ORGANIC AGRICULTURE - PLANT & LIVESTOCK PRODUCTION

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PREFACE

Having its own principles and practices in the process from farm to fork, organic farming is extremely important for a sustainable agricultural system and human health. The European Union (EU) announced the “European Green Deal” on November 11, 2019, as a commitment to take firm and assertive steps on environmental and social sustainability issues. On May 20, 2020, it adopted the “Farm to Fork Strategy” for a fair, healthy, and environmentally friendly food system and the “Biodiversity Strategy” for eradicating the destruction of nature. Within the framework of these strategies, the use of pesticides will be reduced by 50%, the use of chemical fertilizers by 20%, the sales of antimicrobials by 50%, and organic farming areas will be enlarged to constitute 25% of the total agricultural land until 2030. It will be ensured that at least 10% of agricultural areas will have achieved high biodiversity by then.

To support sustainable practices, the Strategy offers new "eco-plans" as an important funding stream for promoting practices such as precision agriculture, organic farming, agroecology, agroforestry, and stricter animal welfare standards. Furthermore, it is expressed that the organic food market will continue to grow and organic farming should be supported further due to its positive effects on biodiversity, creating employment opportunities, and attracting young farmers.

Following the announcement of the European Green Deal, the leading actors of international trade started to set similar goals. It appears as a necessity for Turkey, which performs nearly half of its trade activities with the EU, to direct its policies in all relevant fields by closely following the steps the EU will take. In this process, the Ministry of Commerce has prepared the "Green Reconciliation Action Plan" as of 2021. According to this Plan, studies will be conducted to decrease the use of pesticides, antimicrobials, and chemical fertilizers in Turkey in compliance with the goals set by the EU to reduce pesticides and antimicrobials. It is targeted to implement initiatives with the EU to develop organic farming, to complete the harmonization studies of the EU's organic farming legislation and to ensure mutual recognition with the EU in the field of organic farming to promote trade in organic farming between Turkey and the EU.

It is of great importance to conduct any kind of research and to put the results into practice in organic farming so that Turkey, which has highly suitable ecological conditions for organic production and high export potential, can reach the desired level in the world organic market.

In this book, which was prepared with the intensive efforts of experienced and competent scientists in both organic plant production and organic livestock production based on the aforesaid need, the condition, basic principles, and application principles of organic farming in the world and Turkey are discussed. It is aimed to be helpful for all those who will carry out research and practices in the field of organic farming within the framework of the European Green Deal.

We would like to thank all the authors who did not hesitate to devotedly share their experiences and valuable knowledge in this book.

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PART-I

PLANT PRODUCTION

CHAPTER 1

AN OUTLOOK FOR ORGANIC AGRICULTURE: DEVELOPMENTS IN TURKEY AND THE WORLD

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INTRODUCTION

The ability to live in a clean environment is critical for the survival of living organisms on the planet. Overusing chemical fertilizers, pesticides, and weedicides in agricultural activities have caused problems for the entire ecosystem, even though technology-induced farming is necessary to feed the world's expanding population. The eco-friendly farming system has emerged as the only solution for ensuring the long-term sustainability of agricultural production (Singh, 2021). Solving agricultural environmental problems in the world constitutes the first step of sustainable agriculture systems based on human health and the protection of natural resources. Organic farming, which emerged in this context, is presently one of the most common sustainable farming systems (Eryılmaz et al., 2019).

Organic agriculture is based on principles that try to find solutions to environmental issues. It is a production system that produces organic food, taking into account biodiversity, biochemical cycles, and the increased biological activity of the soil. The organic food market is expanding at a rapid pace around the world, especially in countries where it is no longer regarded as a niche market. However, because of the influence of economic, institutional, and political factors, organic food consumption is still low in many countries around the world (Stoica et al., 2020).

Organic agriculture does not mean “natural agriculture” or “fertilizer-free and pesticide-free agriculture”. Organic farming means a sustainable eco-system, which is a holistic systems approach based on a set of processes that result in safe food, healthy nutrition, social justice, and better environmental living conditions. For this reason, organic production means more than just a production system that includes or excludes certain inputs (Kırımhan, 2005). In this respect, organic agriculture, which is based on protecting human health and the environment, has become an important economic activity in Turkey as well as all over the world in recent years. Since Turkey has a suitable climate, soil, and water resources across a wide geography, it is a country that is extremely favorable for organic agriculture. Turkey is rich in product diversity, and all geographical regions come to the fore with certain products. In addition to the opportunities to supply the necessary inputs for organic agriculture, there is also an important domestic consumer potential that will demand organic products. There are many advantages of organic agriculture in terms of producers and consumers in Turkey (Ayla & Altıntaş, 2017):

- It reduces input costs due to the permissible use of inputs whose prices are increasing day by day in conventional agriculture.
- Provides a purchasing guarantee for farm commodities produced with a contracted system.
- The export prices of organic products are higher than domestic market prices by approximately 10-20%.
- Since most of the lands owned by developing countries are suitable for organic farming, it is easy to switch to organic farming.

- Makes significant contributions to creating new jobs and solving the unemployment problems particularly in rural areas.

Turkish organic agriculture began as contract production to meet the demands of developed countries, and this was the beginning of the country's organic agriculture. At the start of the production, there was only a small selection of products available. However, it has gradually increased as a result of both the increasing demand from developed countries and the ease with which the product can be sold in those countries. As a result of the increase in production, a large number of producers decided to enter this industry. Therefore, organic agricultural production and marketing in Turkey eventually gained acceptance in international markets (Kızıltuğ & Fidan, 2016).

Turkey is now one of the largest global organic suppliers in Europe with a continuously increasing market share. A significant increase has occurred in both the number of organic farm properties and the area of organically farmed land in recent years. However, the country's organic agriculture market accounts for only 0.1% of the world's total organic agriculture market (Akyüz & Theuvsen, 2021). Many different subsidies are provided by the government to convince farmers to adopt organic agriculture accross the country. Among these are low-interest loans and direct income support, support with the protection of environmentally sensitive terrain, suport for adopting good agricultural practices and soil analyses, supports for exports, and support for the leasing of public lands to investors who commit to investing in organic agriculture and employing at least 10 people for ten years (Bahşi, 2019).

Since organic agriculture has become important in both developing and developed countries, the interest shown by academics in the subject is also increasing. This study aims to 1) deal with organic agriculture in a conceptual framework, 2) examine the legislation on organic agriculture in the world and Turkey, 3) determine the current situation of organic agriculture in the world and Turkey, and 4) present the marketing structure of organic products in the world and Turkey with up to date statistical data. It is thought that this study may provide useful information to experts who will develop policy and strategy on organic agriculture, producers and producer organizations engaged in organic agriculture, personnel of the Ministry of Agriculture and Forestry, researchers, and all other stakeholders.

1. THE CONCEPT OF ORGANIC AGRICULTURE

After the 1929 Economic Crisis, the first implementer of the interventions in the agricultural sector was the United States (US). To increase agricultural production and productivity, states are working on the dissemination of agricultural technology. They finance the agricultural sector and try to protect it against foreign competition with a series of tools such as minimum price applications, agricultural input supports (seed, fertilizer, pesticide, diesel, etc.), or export subsidies (Karabağ, 2021). Particularly with the agricultural technologies initiated in the 1960s, and implemented within the scope of the Green Revolution, an agricultural production increase of closed to 100% has been achieved. This boom in production level is accounted for one of the most significant technological developments of the twentieth century. However, as these farming techniques cause the ecosystem to deteriorate very rapidly, it has come to the brink of unsustainable development. Soil, water, and air were polluted, and foods produced using various chemical pesticides and fertilizers caused serious health problems in humans (Bayram et al., 2007: Ak, 2004).

Agricultural practices aimed at providing more efficiency in the world have led to overexploitation of the soil, environmental pollution, deterioration of the natural balance and product quality, and the emergence of residues in the product. Conscious producers and consumers have come together to introduce and develop the concept of organic agriculture for the elimination of these negativities and the production and consumption of healthier products. In recent years, the interest in organic agriculture has been increasing, but the content of the concept of organic agriculture cannot be fully filled and there is conceptual confusion in this regard. According to Demiryürek (2016), organic farming is not “fertilizer and pesticides - free farming”, “natural farming” or “traditional farming”. It can be seen as an approach to sustainable and integrated agricultural systems, which have their specific principles and practices in the process from growing to the selling of organic products. The term “organic” was first used by W. Northbourne in 1940 to describe the ecological farming system in his work “Look To The Land” (Tıraşçı et al., 2020). Organic farming is called by different names in different countries due to language differences. For example, the word organic is used in England, ecological in Germany, and biological in France. However, they are generally used synonymously with each other (Demiryürek, 2004).

Organic agriculture has been defined by different organizations in various aspects. For example; the United States Department of Agriculture (USDA) National Organic Standards Board defined organic agriculture in 1995 as "… an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, and enhance ecological harmony" (USDA, 2021). Another commonly accepted definition was made in 2005 by the General Assembly of the International Federation of Organic Agriculture Movements (IFOAM) which states that "organic agriculture is a production system that sustains the health of soils, ecosystems, and people". According to this definition, in organic agriculture, special attention is paid to agricultural production processes that do not use inputs that have negative effects on the environment. In addition, biological diversity and compatibility with local conditions are extremely important. Organic agriculture is based on using the common environment in the most appropriate methods, combining the traditions of the region with innovations and scientific rules. In this way, fair relations and quality life opportunities are provided for all human beings and all other parties involved in the process (IFOAM, 2021a).

According to IFOAM, organic agriculture is based on four basic principles: Health, ecology, fairness, and care (IFOAM, 2021b):

Principle of Health: Organic farming must protect and promote the health of the soil, plants, animals, humans, and the entire planet as an indivisible whole. According to this principle, the health of individuals and communities cannot be separated from the health of ecosystems. Healthy products are grown in healthy lands, and people and animals who consume these products lead healthier life.

Principle of Ecology: Organic farming should be based on living ecological systems and cycles, work with these systems and cycles and strive to be sustainable. This principle links the origin of organic farming to existing ecological systems. Accordingly, production should be based on ecological processes and recycling. Nutrition and well-being are provided by the ecology of a particular production environment. This environment is living soil for crop production, a farm ecosystem for animals, and an aquatic environment for fish and sea creatures.

Principle of Fairness: Organic farming should establish fair human relationships among all stakeholders including farmers, workers, processors, distributors, traders, and consumers involved in different stages from pre-production to post-consumption with regard to the common environment. Fairness is characterized by equality, respect, and justice in the management of the shared world, both in human relations and in human relations with other living organisms.

Principle of Care: Organic farming should be managed prudently and responsibly to protect the environment, as well as the health and well-being of current and future generations. Organic agriculture is a lively and dynamic system that responds to domestic and foreign demands and conditions. Organic farming practitioners can increase efficiency and productivity in production, but this increase should not risk compromising health and well-being. For organic farming, new technologies need to be evaluated and existing methods need to be reviewed. Considering the lack of understanding of ecosystem and agriculture, attention should be paid to the issues.

The term organic agriculture in Turkey was defined by the Ministry of Agriculture and Forestry (2021) as the form of an environmentally friendly production method that will meet the need for the development of agricultural techniques that minimize erosion and salinization of the soil, and the effects of other diseases and pests without polluting the air, water, and soil. The crop production areas, animals, bees, and aquaculture which are planned to convert to organic agriculture are included in the transition process. The products obtained twelve months after the start of organic agriculture in plant production are considered transitional products. The transition product is marketed with the label “organic agriculture transition product”. However, products obtained from animals in the transition period cannot be marketed as transitional products, and expressions reminiscent of organic agriculture cannot be used in their advertisements and labels (Official Gazette, 2010).

The organic agriculture logo on organic products is a guarantee that production techniques that protect human and environmental health are used. Products defined as 100% natural, hormone-free, genuine, village product, or pure product are not considered organic products. Label and logo of organic products, and their advertising and promotion cannot be fake, and misleading consumers with different text, pictures, figures, etc. For this reason, when buying organic products, the label and logo of the products should always be carefully examined. Labeled products should include the name-logo of the organization authorized by the Ministry of Agriculture and Forestry, code number, entrepreneur or product certificate number, the organic product logo specified in the Regulation on the Principles and Implementation of Organic Agriculture, and the content of the product should be included in a complete list (Ministry of Agriculture and Forestry, 2021). Based on the definitions made about organic agriculture, the following four issues come to the fore (Demiryürek, 2016):

- The use of synthetic chemicals, inorganic and soluble substances such as pesticides, fertilizers, animal hormones, and plant growth regulators are prohibited in organic agriculture.
- Organic agriculture is based on certain production principles such as plant rotation, utilization of plant residues as compost, using animal manure, practicing biological-mechanical and integrated pest control, dealing with diseases, and applying weed control practices.

- Organic agriculture aims to protect consumer health, takes into account their preferences and realizes closed system agricultural production among soil, plant, animal, and farm systems based on the principles of protecting soil fertility.
- Organic agriculture and marketing activities are registered, transparent, and traceable processes with their own international rules and regulations.
- Organically produced commodities are certified and controlled by independent certification and control organizations, and experts affiliated to the relevant ministry at all stages of this process, and receive an organic product logo.

2. ORGANIC AGRICULTURE LEGISLATION IN THE WORLD AND TURKEY

Legal regulations and standards are of great importance for the correct implementation of the organic farming system. While studies focused on organic agriculture at the national level of many countries were independently carried out, they were gathered under the umbrella of IFOAM after the 1970s. All countries in the world follow IFOAM's basic standards. Among the international standards, the basic standards called "Organic Guarantee System" (OGS) by IFOAM attract the most attention. In addition, there are organic agriculture standards within the general standards (Codex Alimentarius) created jointly by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO). Another generally accepted standard that draws attention among many international organizations related to organic agriculture is the Demeter International Standards. The European Union (EU) organic farming legislation has also international validity (Emir et al., 2012).

The first official legislation enacted in the world was the directive numbered 2092/91, which was published on July 24, 1991, and entered into force in the EU. The EU later made many revisions to the directives (Kılıçaslan, 2015). After the EU regulation 2092/91 was repealed, the 834/2007 and 889/2008 directives, which are called the new period, came into force (Fruscella et al., 2021). The overall goal of Council Regulation (EC) 834/2007 is to lay the groundwork for developing a long-term sustainable organic farming sector in Europe. Although the term sustainable development is not defined in the legislation, it is clear that it must be considered in the context of organic production methods' dual societal roles, namely, providing food in response to consumer demand for organic products and delivering public goods that contribute to the protection of the environment and animal welfare, as well as to rural development. According to the eighth evaluation question, the extent to which organic farming legislation has contributed to the sustainable development of the sector depends on whether this development has been economically, environmentally, and socially sustainable (Sanders, 2013). The legislative framework of the EU has been supplemented several times since 2009. For example, there have been supplements in organic rules on aquaculture (Regulation (EC) 710/2009), wine production (Regulation (EC) 203/2012), trade with third countries (Regulation (EC) 508/2012), and controls (Regulation (EC) 392/2013) (Sanders, 2013). The Expert Group for Technical Advice on Organic Production (EGTOP) published a report titled “Final Report on Greenhouse Production (Protected Cropping)” in 2013. Many of these recommendations have been included in the new Commission Regulation (EU) 2018/848 (Fruscella et al., 2021).

Besides the international standards on organic agriculture mentioned above, almost every country has its national legislation. Notable among these and valid in international trade are the “National Organic Program (NOP)” of the USDA, Japanese Agricultural Standards (JAS) of organic agriculture, Canadian National Organic Agriculture Standards, and the Australian Organic Certificate (ACO) can be specified (Demiryürek & Bozoğlu, 2007). The NOP national standards prohibit the use of transgenic seed, the majority of synthetic fertilizers, and pesticides, and require that animals have a certain level of pasture access (Delbridge et al., 2017). In Japan, the JAS serves as the foundation for organic certification and labeling. The JAS mark is applied to products that adhere to specific standards as determined by certification bodies. Apart from the food label, certified products must include predefined information, such as the country of origin and the distributor’s name (Täumer, 2015). The National Standard of Canada for Organic Agriculture was voluntary, unlike the majority of other government standards. In September 2006, Canada enacted mandatory standards. The Canadian standard is based on the Codex Alimentarius Commission’s guidelines for the “Production, Processing, Marketing, and Labeling of Organically Produced Foods", and the Standards Council of Canada (SCC) accredits organic foods using ISO 65 as the basis (Sawyer et al., 2008). The ACO is an organic and biodynamic produce certifier. They provide certification services to operators in all sectors of the organic industry, ensuring that national production standards are met, and allowing for the traceability of all products (Malkanthi, 2020).

Organic agriculture in Turkey has been organized through various pieces of legislation that can be divided into two distinct eras: Before and after the 2004 organic law.

Prior to the 2004 Organic Law: There were no national legal regulations in place. Organic agriculture activities began in response to requests from Western European companies and were conducted following the legislation of the importer countries during this period. The European Council adopted Council Regulation (2092/91) in 1991, requiring countries exporting organic products to the European Community (EC) to publish their national legislation. In 1992, Turkey's first official organic agricultural movement was founded by the Association of Ecological Agriculture. The regulation titled Ecological Methods for the Production of Plant and Animal Agricultural Products was published on December 18, 1994. The regulation Establishing Ecological Methods for the Production of Plant and Animal Products (22145) was published on December 24, 1994. Turkey's first organic agricultural activities were brought under the Ministry of Agriculture and Rural Affairs' control and established rules as a result of this regulation. Amendments to this regulation were necessary to conform to changes in EU legislation, and on July 11, 2002, a new regulation titled Principles and Practices of Organic Agriculture (24812) was published. Additionally, this regulation incorporates regulations governing organic animal production and traditional fisheries (Boz et al., 2011; Kılıçaslan, 2015).

Following the 2004 Organic Law: Turkey's most effective organic agriculture legislation was enacted with the passage of the Organic Agriculture Law (5262) on December 3, 2004. The law establishes standards for organic product production, consumption, and inspection. It strengthened the previous organic agriculture regulations' legal amendments. Additionally, the duties and responsibilities of the parties involved in organic processes were established, as well as the penalties for violating the law and regulations. On June 10, 2005, the regulation titled Principles and Practices of Organic Agriculture (25841) became effective, based on the organic law. This regulation was issued to become a member of the list of countries that export organic products to the EU and was drafted following Council Regulation (2092/91). This regulation enabled the export and marketing of organic agricultural products in the desired varieties and quantities to foreign markets. On October 10, 2006, the Regulation on the Principles and Application of Organic Agriculture (26322) was published to ensure that internal amendments to EU legislation are made (Kılıçaslan, 2015). On August 18, 2010, to comply with new EU legislation, the regulation titled Principles and Practices of Organic Agriculture (27676) was published.

On October 6, 2011 (28076), August 14, 2012 (28384), May 24, 2013 (28656), February 15, 2014 (28914), July 22, 2015 (29422), and January 10, 2018 (30297), this regulation was amended (Boz & Kaynakçı, 2019).

3. ORGANIC AGRICULTURE IN THE WORLD

In developed countries, the market has a high level of capacity that is constantly expanding. The organic policy is an integral part of the concept of sustainable development approach to natural resource management. The policy is aimed at long-term market expansion, rural development, stimulating research, and diversifying high-value-added organic products (Kyrylov et al., 2018). As of 2019, organic farming is carried out in 187 countries in the world. The organic farming area has increased approximately 6.6 times from 1999 to 2019, reaching 72.3 million hectares. In terms of organic farming area size, Australia (49.4%) ranks first. As of 2019, only 1.5% of the world's agricultural areas are organic. When the number of organic producers is examined, it is seen that there were 3.1 million organic producers in the world in 2019. India is the country with the highest number of organic producers in the world, with approximately 1.4 million. The organic market size in the world, which was 15.1 billion euros in 2000, increased to 106.4 billion euros in 2019. The country with the largest organic market size in the world is the US (44.7 billion euros), while the country with the highest per capita consumption of organic products is Denmark (344 euros) (Table 1).

Table 1. Organic Agriculture: Key Indicators and Top Countries

	World	Top countries
Countries with organic activities	2019: 187 countries	
Organic agricultural land	2019: 72.3 million ha (1999: 11 million ha)	Australia (35.7 million ha) Argentina (3.7 million ha) Spain (2.4 million ha)
Organic share of total agricultural land	2019: 1.5%	Liechtenstein (41.0%) Austria (26.1%) São Tomé and Príncipe (24.9%)
Wild collection and further non-agricultural areas	2019: 35.1 million ha (1999: 4.1 million ha)	Finland (4.6 million ha) Zambia (3.2 million ha) Namibia (2.6 million ha)
Producers	2019: 3.1 million producer (1999: 200 000 producers)	India (1 366 226) Uganda (210 353) Ethiopia (203 602)
Organic market	2019: 106.4 billion euros (2000: 15.1 billion euros)	US (44.7 billion euros) Germany (12.0 billion euros) France (11.3 billion euros)
Per capita consumption	2019: 14.0 euros	Denmark (344 euros) Switzerland (338 euros) Luxembourg (265 euros)

Source: FIBL, 2021

Until 2009, 72.3 million hectares of agricultural land were managed organically on a global scale. Oceania, with 35.9 million hectares of organic agricultural land, is the region with the largest area available for organic farming. Europe came in second with 16.5 million hectares, Latin America came in third with 8.3 million hectares, Asia came in fourth with 5.9 million hectares, North America came in fifth with 3.6 million hectares, and Africa came in sixth with 3.6 million hectares (2.0 million hectares). Oceania controls more than half of the world's organic agricultural land. Europe, a region that has consistently increased its organic agricultural land over the years, now accounts for over 23% of the world's organic agricultural land, followed by Latin America at 12% (Table 2).

Table 2. World: Organic Agricultural Land (including in-conversion areas) and Regions Shares of the Global Organic Agricultural Land (2019)

	Organic agrıcultural land (ha)	Regions' shares of the global organic agricultural land (%)
Oceania	35 881 053	49.6
Europe	16 528 677	22.9
Latin America	8 292 139	11.5
Asia	5 911 622	8.2
Northern America	3 647 623	5.0
Africa	2 030 830	2.8
World*	72 285 656	100.0

* Includes correction value for French overseas departments
Source: FIBL, 2021

In Figure 1, the first 17 countries in the world where more than 10% of the total agricultural land is allocated to organic agriculture and the share of the land allocated to organic agriculture in Turkey are given. Liechtenstein (41.0%), Austria (26.1%), and São Tomé and Príncipe (24.9%) are the countries with the largest organic farming areas in their total land area. Turkey, which allocates 1.4% of its total land to organic agriculture, ranks 50th.

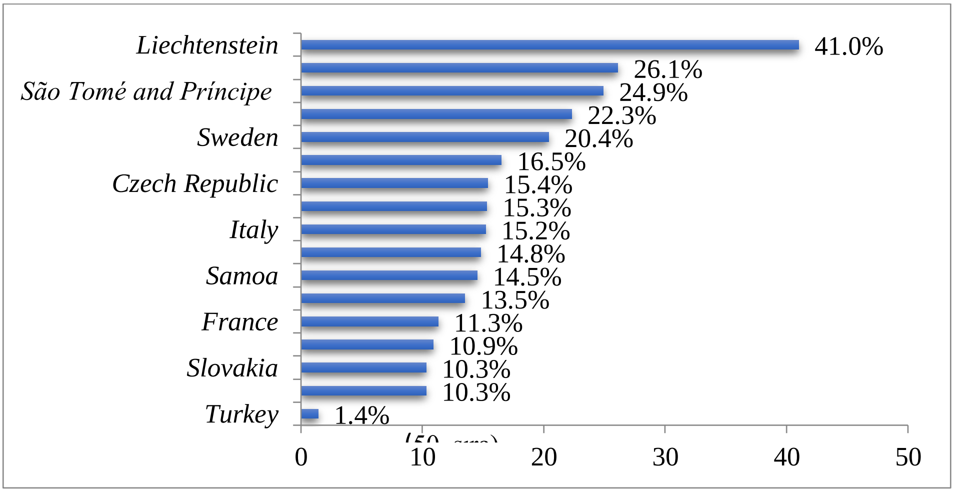

Figure 1. The Countries that Allocate more than 10% of their Agricultural Lands to Organic Agriculture and the Situation of Turkey (FIBL, 2021)

4. ORGANIC AGRICULTURE IN TURKEY

The majority of developing countries have been unable to establish organic markets, and as a result, their organic production is heavily reliant on export, which is the primary source of income for farmers. There is a low level of soil pollution, low land use costs, and cheaper labor available for organic farming, which provides these countries with competitive advantages. At the outset, when financial constraints, underdeveloped market infrastructure, low technological level of production, and low farmer and consumer awareness exist, direct payments per unit area for conventional farming transformation and consulting support are critical (Kyrylov et al., 2018).

In Turkey, which is a developing country, organic agriculture started in the Aegean Region in the mid-1980s in line with the demands of European importers and then spread to other provinces. Although farmers pioneered the organic farming movement in developed countries, European private organic farming companies played an active role in the adoption of organic farming in Turkey (Demiryürek, 2011). Turkey, in terms of production area and the number of organic farmers, is one of the countries that has entered the trend of development of organic agriculture in recent years. While the number of products cultivated organically in Turkey was 8 until 1990, this number increased to 213 in 2019. Turkey is the country with the highest number of organic producers in Europe as of 2019 (IFOAM, 2021). In the ten-year period covering the years 2010-2019, the number of organic producers increased from 42097 to 74547. In the same period, although the total organic production area increased or decreased in some years, it did not change much from 2010 to 2019 (Table 3). The reasons for these fluctuations, according to Bilen and Çiçekli (2019), are changes in the data collection system, rapid increases and decreases in the natural collection, and changes in support.

Table 3. Organic Farming Crop Production Data (including the transition period)

	Number of crops	Number of farmers	Area planted (ha)	Natural collection area (ha)	Total production area (ha)
2010	216	42 097	383 782	126 251	510 033
2011	225	42 460	442 581	172 037	614 618
2012	204	54 635	523 627	179 282	702 909
2013	213	60 797	461 395	307 619	769 014
2014	208	71 472	491 977	350 239	842 216
2015	197	69 967	486 069	29 199	515 268
2016	225	67 878	489 671	34 106	523 778
2017	214	75 067	513 981	22 148	543 033
2018	213	79 563	540 000	86 885	626 885
2019	213	74 547	502 127	3 424	505 551

Source: Ministry of Agriculture and Forestry, 2021

Since Turkey has a suitable climate, soil, and water resources in wide geography, it is a country that is extremely suitable for organic agriculture. In terms of product diversity, all geographical regions stand out with certain products. In addition, there are opportunities to supply the necessary inputs for organic agriculture in the domestic market, and there is also a significant consumer potential that will demand the organic products produced in the domestic market. In every region of Turkey, there are many products grown organically within the existing agricultural system. As of 2019, organic farming is carried out in 77 provinces in Turkey. Among these provinces, Aydın has the highest share of the total organic production area (14.6%). Other important provinces in terms of organic farming area are Kars (12.0%), Ağrı (8.5), and Van (8.0%) (Table 4).

Table 4. Organic Agricultural Production Data (2019)

	Number of producers	Total area (ha)	Total area (%)
Aydın	11 107	56 191	14.6
Kars	3 177	46 380	12.0
Ağrı	1 366	32 961	8.5
Van	2 493	31 041	8.0
Muş	1 946	24 814	6.4
Erzurum	1 561	21 305	5.5
Kastamonu	34	21 274	5.5
İzmir	2 227	15 158	3.9
Manisa	2 441	13 785	3.6
Adana	75	8 793	2.3
Others		271 702	70.4
Total		386 074	100.0

Source: Ministry of Agriculture and Forestry, 2021

5. MARKETING OF ORGANIC PRODUCTS IN THE WORLD

Agricultural products and food in the majority of developed countries can be classified according to how they are produced and sold in various markets: They can be produced organically or conventionally and are sold in both local markets and by mainstream retailers. Three circles represent these categories (Figure 2), where mainstream and conventional are combined to describe food that is produced conventionally, is not certified, and is sold mainstream through supermarket chains. Due to the fact that this is where the majority of food production and sales occur, the circle is larger than the others (but not proportionate to reality). The figure's purpose is to demonstrate where these categories intersect and where they do not: Food that is organically certified can be sold in either the mainstream or locally, and food that is locally sold can be organically certified or conventionally produced (Milford et al., 2021).

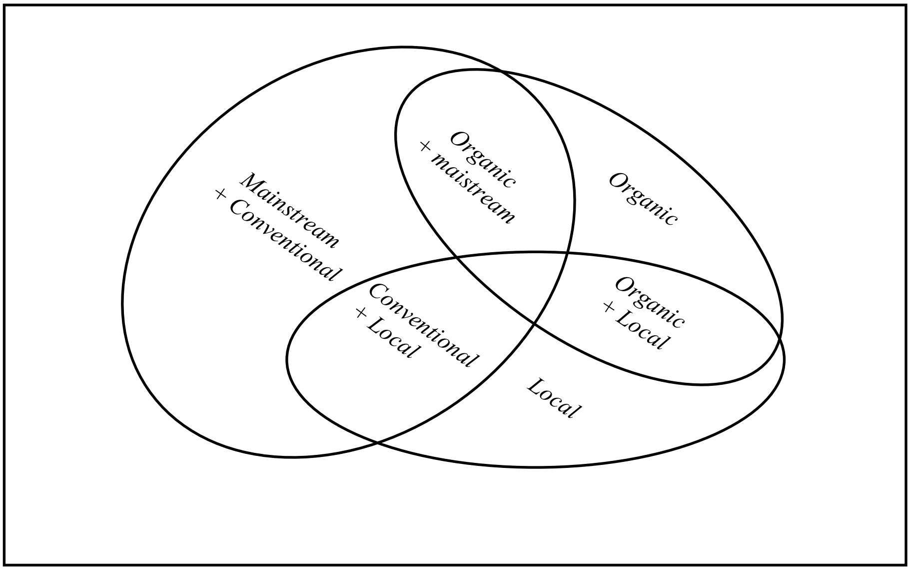

Figure 2. Mainstream Conventional, Organic, and Food Systems

The US is the fastest growing country in organic farming. Since the USDA's National Organic Program was implemented in 2002, the organic industry has continued to grow (Silva et al., 2014). The US has the world's largest organic market with a global value of 44721 million euros as of 2019, while Germany and France are the other countries with significant organic market sizes, respectively (Figure 3).

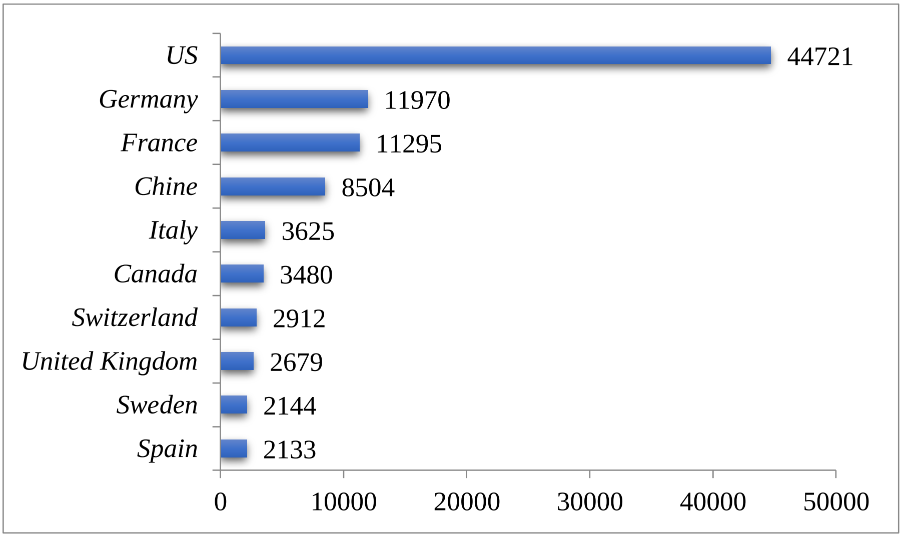

Figure 3. Global market: The Countries with the Largest Markets for Organic Food (million euros) (2019) (FIBL, 2021)

Organic food consumption has been recommended as a means of achieving a more sustainable society. As a result, it has risen considerably in recent years in response to consumer concerns about health, well-being, and environmental challenges. As of 2019, Denmark ranks first in organic product consumption per capita in the world with 344 euros. After Denmark, Switzerland (338 euros) and Luxembourg (265 euros) are the countries that consume the most organic products per capita. According to 2014 data, organic consumption per capita (1 euro) in Turkey is quite low (Figure 4).

Germany, France, Italy, and Spain all began their organic food consumption and production movements, making Europe the second-largest organic food market in the world. Despite this, the average percentage of spending on organic foods remains low (Lawson et al., 2018). Differences in agricultural understandings and imaginaries in

Austria, Italy, and France have allowed for diverse relationships to be attached to organic techniques. Agriculture is viewed as multifunctional in Austria, and so as providing a public utility. This allowed organic farming organizations to emphasize their role in preserving family farms and the cultural landscape. In France, on the other hand, agriculture has been viewed primarily through the lens of its productive role and a technicist-modernist framework, making it more difficult for organic actors to establish relationships with the state and other societal actors. In Italy and France, consumers had well-established associations with traditional specialties and geographical indications, and local was not tied to organic in the same way as it was in Austria, making it more difficult for organic food to convey a relevant quality (Darnhofer et al., 2019).

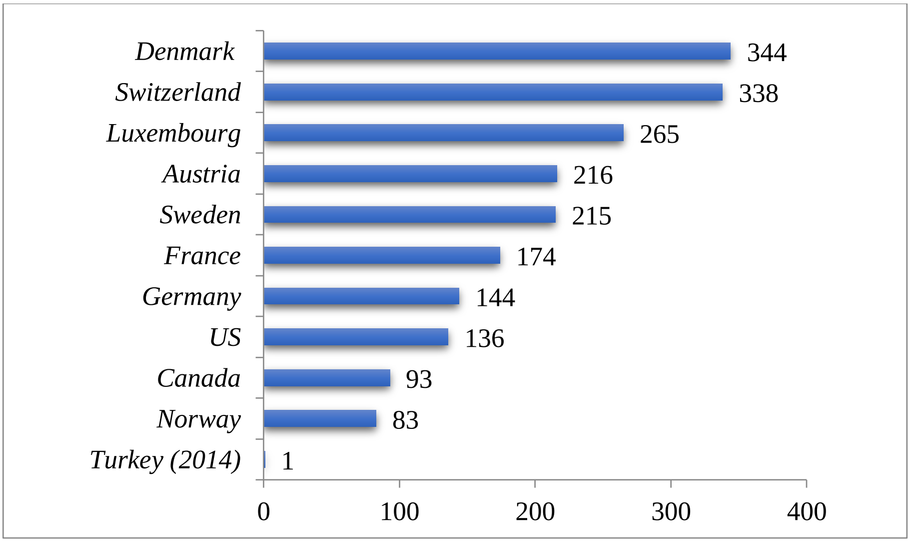

Figure 4. The Ten Countries with the Highest Per Capita Consumption and the Situation of Turkey (euros) (2019) (FIBL, 2021)

While the developed countries in the world mostly practice organic agriculture to meet the domestic demand, there is an export-based organic agriculture structure in the developing countries. As of 2019, China ranks first among the world's organic product exporter countries with 433705 metric tones. In Turkey, which ranks 6th in organic product exports, there was a 19.8% decrease in 2019 compared to 2018. In the same period, organic product exports of Kazakhstan and India, two other important exporting countries, increased by 70.5% and 40.7%, respectively (Table 5).

Table 5. Organic Import Volumes by Exporting Country

		2018 Imports (Metric tones)	2019 Imports (Metric tones)	Change (%)
1	Chine	404 623	433 705	7.2
2	Ukraine	265 817	337 856	27.1
3	Dominican Republic	271 801	324 354	19.3
4	Ecuador	276 879	304 297	9.9
5	Peru	204 871	214 240	4.6
6	**Turkey**	**262 722**	**210 760**	**-19.8**
7	India	125 477	176 568	40.7
8	Colombia	63 114	87 341	38.4
9	Kazakhstan	50 250	85 675	70.5
10	Brazil	72 204	78 825	9.2

Source: FIBL, 2021

6. MARKETING OF ORGANIC PRODUCTS IN TURKEY

There are many different distribution channels in the marketing of organic products in Turkey. The number of wholesalers and retailers varies according to geographical and economic conditions. Although organic agricultural products reach the last point of sale in different ways, the marketing models of these products are also different from each other. The most known and common of these is the producerwholesale-retailer-consumer chain. With the increase in information technologies, marketing models from the producer to the end-user are also developing (Pektaş, 2019).

Indispensable principles such as consultancy, inspection, and certification of these organic production activities in Turkey in the first years were completely fulfilled by foreign individuals and organizations. At the beginning of the 1990s, Turkish experts, albeit a small number, were trained and they started to represent foreign companies in Turkey. There are four main ways of marketing organic products in Turkey (Öztürk & İslam, 2014):

- The production project is carried out by a company located in the country and the products are processed, packaged, and exported by this company.
- The production project is made by a foreign organization from abroad. The products produced according to the project are processed by the contracted local company and these products are exported by the project owner company, processing organization, or export company.
- Products whose production project is made by a foreign organization from abroad are processed in the facilities established by the foreign company alone or jointly in Turkey. The products are exported to the project owner company by the processing organization or the exporting company.

- In a small number of applications, farmers certify their products by contacting the control and certification company directly and offering them for sale in the free market.

The marketing of organic products is not much different from conventional products. However, the characteristics of organic products and the characteristics of their consumption also create differences in the strategies that producers will follow in the marketing of organic products. The marketing strategies of organic products are given in Table 6 (Kılıç et al., 2014).

Table 6. Marketing Strategies of Organic Products

Target Market: Women aged 20-40, customers with children, and customers with high income
Product Categories: Fresh, dried, and frozen vegetable and fruit products, Mediterranean products, fruit juice concentrates, and legumes product group
New Product Development Decision: In line with consumer demand
Packaging: The packaging should be in different colors and sizes, protecting the product, and attractive in terms of color and design.
• Pricing Strategies: Market skimming strategy
• Distribution Strategies: Ecological or organic markets, few effective intermediaries
• Promotion Strategies: In-store self arrangements, in-store promotions, advertising, and personal selling efforts

Determining the right strategies in domestic marketing of organic agricultural products is important in terms of profiting companies against conventional alternative products. However, in an important agricultural country like Turkey, it is expected that the organic market will be expanded through exports in organic agricultural products, as in all other agricultural products. While the export of organic agricultural products in Turkey was mostly unprocessed in the first years, today the amount of processed and exported organic products is increasing. The reason for this is that marketing organic products by processing and increasing their durability are more profitable for the country's economy, exporter, and producer. According to 2019 data, the highest share in total organic agricultural product exports in Turkey, with 32.1%, belongs to fruit and fruit products. Afterward, figs and fig products come second with 19.8%, and hazelnuts and hazelnut products come third with 15.7% (Table 7).

Table 7. Exports of Organic Agricultural Products (2019)

	($)	(%)
Fruit and fruit products	65 242 625.0	32.1
Fig and fig products	40 306 275.0	19.8
Hazelnut and hazelnut products	31.964.563,3	15.7
Grape and grape products	27 895 275.7	13.7
Apricot and apricot products	14 727 473.0	7.2
Wheat and wheat products	11 913 987.3	5.9
Corn	2 983 475.4	1.5
Spices	1 850 383.9	0.9
Vegetable and vegetable products	1 694 270.5	0.8
Pistachios	1 566 455.3	0.8
Olive and olive products	394 232.1	0.2
Eggs	184 628.1	0.1
Milk and milk products	129 053.2	0.1
Poultry products	89 979.7	0.1
Others	2 198 960.8	1.1
Total	203 141 638.2	100.0

Source: Ministry of Agriculture and Forestry, 2021

7. CONCLUSIONS

Land and natural resources are increasingly under threat as a result of the intensive use of inputs in agriculture. For this reason, reliable, natural, and environmentally friendly agricultural production systems come to the fore in terms of human health. Organic farming, which emerged in this context, is becoming more and more important. Although organic agriculture has been practiced for many years, it is seen that more progress has been made in developed countries in terms of legislation, producer, and consumer awareness. Unlike developed countries that produce for the domestic market, organic agriculture in developing countries is mainly important to meet the foreign market's demand.

As of 2019, organic farming is carried out in 187 countries in the world. Some of these countries can be considered pioneers in terms of criteria such as the share allocated to organic farming areas, market size, and per capita consumption. The countries with the largest organic farming areas in their total land area are Liechtenstein, Austria, and São Tomé and Príncipe. In terms of the number of producers, India, Uganda, and Ethiopia stand out. On the other hand, the USA, Germany, and France are the countries with the largest organic market size. Organic product consumption per capita is the highest in Denmark, Switzerland, and Luxembourg, while organic consumption per capita in Turkey is quite low.

The increase in the demand for organic products all over the world in recent years can be accepted as an indicator of the need for reliable food. Turkey, which is among the leading countries in the world in terms of organic agriculture area and the number of organic farmers, is far from the level of developed countries in domestic consumption. The most important reason for the low consumption of organic products in Turkey is that, like other developing countries, there is an export-based structure and organic products cannot be sufficiently spread to the domestic markets. For the development of organic agriculture in Turkey, suitable climatic conditions, fertile soil structure, and adequate water resource potential should be utilized. Since there is less industrialization and urbanization in the eastern provinces of Turkey, they are more suitable for organic agriculture, and the conversion to organic agriculture is relatively easier than the western provinces. Therefore, there have been positive developments in these provinces, especially in recent years. Aydın province has the most organic farming area in Turkey, while Kars, Ağrı, and Van located in the Eastern Anatolia Region are other important provinces.

To achieve faster progress in organic agriculture in Turkey, there is a need to increase the awareness of producers and consumers about organic agriculture and its products. Legal regulations should be increased to prevent ambiguity and misconceptions caused by expressions such as “natural product”, “village product”, “fertilizer-free” or “pesticide-free” products. People and organizations engaged in the production and marketing of organic products have an important responsibility for the correct promotion of organic agriculture. In addition, easy access to organic products can have a positive effect on consumer purchasing behavior. For this, it is important to carry out the necessary studies on the regular establishment of organic markets not only in metropolises but also in all provinces and districts.

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CHAPTER 2

BENEFITS OF CROP ROTATION IN ORGANIC AGRICULTURE

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INTRODUCTION

Crop rotation is one of the oldest and most principal agronomical practices. Considering the environmental and economic conditions today, a well-planned crop rotation is the prerequisite for a sustainable and beneficial agriculture. Crop rotation have been practiced in agriculture since ancient times. Roman writers recommended, as an alternative crop substitution systems in that a legume was replaced by a winter grain plant. The importance of proper use of natural resources (such as soil, water) has increased even more today, where global climate change and food shortages are experienced in many countries. Particularly in arid and semiarid regions, in the case of planting crops that require a lot of water, or crops consume much nutrients from the soil during the growing season, this is led to rapid depletion the soil fertility.

Crop rotation is a must for maintaining soil fertility. Applying rotation contributes to increase the amount of organic matter in the soil and provides high yield potential and profitability when the product is replanted. The physical, chemical and biological structure of our soils, where the same product is constantly grown, deteriorates, and the amount of product that emerges due to diseases and pests decreases. In other words, the cultivation of the same product over and over also forces the farmers economically.

The main reasons for the application of rotations; it is to protect from diseases and pests and to ensure the continuity of soil fertility. Crop rotation is even more important in organic farming systems where chemical inputs (chemical fertilizer, insecticide, pesticide) are not used.

In this review, information about the use of crop rotation in organic agriculture, the importance of soil in carbon and nitrogen cycle, its effects on soil quality, weeds and soil microorganisms are summarized.

1. CROP ROTATION

Crop rotation is the sequence of crops on the same land in sequential seasons and implies that crops generally follow a pre-determined order (Bullock, 1992). According to Martin et al. (1976), crop rotation is defined as a "system of growing several types of crops in revolving subrogation on the alike land". Rotating various crops year after year adds different economic and environmental benefits. Furthermore, crop rotation is useful in long-term soil and farm management. The choice of plants to include in crop rotation can influence soil fertility, macro element and microelement content. Rotating various crops can be break pest cycles and add further nutrients to the soil. Crop rotations construct soil fertility, control weeds, keep the environment, maladies, and insects, and add to crop and mart diversity (Baldwin, 2006). Some examples of crop rotations include: corn-soybean (*Glycine max L.*)-wheat/red clover (*Trifolium pratense L.*), corn–soybean, corn–soybean–winter wheat, rice–wheat, and other potential rotations. These crop rotations not only are not universally joint, rather they depend on different environmental and soils statuses. According to reported with Plourde et al. (2013), in the Midwest United States, corn–soybean is the dominating biannual crop rotation, whiles, in Asia, according to Mishra et al. (2012), rice–wheat is the dominating rotation. Studies by Mishra et al. (2012), the alike researchers reported that the rice–wheat crop rotation occupies about 18 million hectare in Asia, of which 75% is in the Indo-Gangetic Plains of India (10 million ha), Pakistan (2.2 million ha), Bangladesh (0.8 million ha), and Nepal (0.5 million ha). Soybean and corn summer crops are broadly grown in rotation with Italian ryegrass (*Lolium multiflorum Lam*) in the subtropical South American regions of Brazil, Uruguay, Argentina, and Paraguay (Neto et al., 2014). Peyraud et al. (2014) reported that small-grain cereals, grain and forage maize, sunflower, and rapeseed (*Helianthus annus L*.) accounted for 75% of crops past wheat. In Europe, cultivation of wheat after rapeseed (*Brassica oleracea* L.), and wheat after small-grain grains is very common.

2. CROP ROTATION AND ORGANIC AGRICULTURE

Crop rotation, the archaic way of growing a succession of plant types on the same ground, is different from intercropping, which consists of cultivating two or more crops at the same time on the same area, or from continuing monoculture, which is the practice of growing single types frequently on the same ground. The main reasons for the application of rotation are to protect it from diseases and pests and to ensure the continuity of soil fertility. Although the positive effect of long-term rotations on crop yields has been recognized and exploited for centuries however, according to Crookston et al. (1991), its benefits in terms of yield seem to have been ignored by many farmers. It is now obvious that crop rotation increases yield and that the action is necessary in sustainable agricultural systems (Mitchell et al., 1991). Foundations of organic cropping systems are effective crop rotations. As a matter of fact, Article 5 of the European Union's principle applicable to organic agriculture (EU 2007) of 834/2007 emphasizes the application of crop rotation to protect/improve soil health and also to minimize dependence on external inputs (Chongtham et al., 2017). A wider description of the principles of organic farming was laid out by IFOAM (2005). Organic farmers know that crop rotation is essential to hold farm productivity. Specialist farmers plan their rotations to (1) earn income and (2) increase soil quality or made “soil stock”. Crop rotation and a crop rotation design and records are necessary for organic attestation of a farm or field. Therefore, the yield of barley in the common barley-soybeans rotation increased by including another winter crops in the rotation (Santos et al., 2000). Generally long-term rotation is no longer included in crop product systems. Different factors have been related to decrease usage of extended rotations, alike the introduction of pesticides and chemical fertilizer, mechanization, and improved crop types (Power & Follett, 1987; Crookston et al., 1991).

By increasing the diversity of flora with rotation practices, the continuity of sustainable agriculture is ensured. In a study conducted for 3 years in conventional and organic farming systems, it was reported that the vetch-fallow-wheat rotation system increased the organic matter content of the soil (Karadas et al., 2007). In addition, both organic farming practices and the intake of legumes in the fallow-wheat rotation system improve the physical and chemical conditions of the soil and contribute positively to soil fertility by causing a significant increase in organic matter in the soil.

Saba & Messina (2003) reported the global request for organically produced food is increasing due mainly to the perceived human health benefits of consuming organic food. According to previously reported nutritional differences among organic and conventionally grown food include increases in micronutrient and high quality N and vitamin content (Worthington, 2001; Bourn & Prescott 2002; Ryan et al., 2008) whiles others alike Zörb et al. (2006), have found low or no differences. However, there are very few well-controlled studies that by Magkos et al. (2003), make authentic comparisons among the nutritional qualities of organic vs. conventionally manufactured food. When in conventional systems use soluble chemical fertilizers, in organic production systems utilize crop rotation and green and animal manures to keep soil fertility. Organic crop rotations range from forage-based systems with different years of alfalfa (*Medicago sativa L.*) to rotations with yearly crops only. Pursuant to Campbell and Zentner (1993), it has been well determinate that the precedent crop rotation will affect the nutrient uptake, growth and nutrient amount of grain in further crops. The extensive diversity of crop rotations usage in organic agriculture may chip in to the conflicting results between studies comparing nutritional amount of the food products. Hence, significant to contrast organic and contractual crop production systems withindoors the base of special crop rotations in instruction to identify the effects of both production system and crop rotation on the nutritional quality of grain.

3. AFFECT CROP ROTATION ON SOIL C AND N CYCLES

According to soil C and N cycles, are all rotations equally effective in SOM protection, GHG publication mitigation, and climate alteration conformity? Up to now, results from literature are not constant about the expanse of the agronomic, environmental, and economic beneficial effects of rotations contrasted with monoculture cropping on yield and SOC amount. West and Post (2002) reported analyzing universal datum from 67 experiments, elevating rotation complexity (i.e., from monoculture to rotation, eschewing fallow periods or increasing the number of crops in the rotation system) separated on mean a very little content of C (15 ± 11 g C m^{-2} yr^{-1}). In the Mediterranean area, rotations including vetch (*Vicia faba L.*; Masri & Ryan, 2009), according to López-Bellido (2010), alfalfa (*Medicago sativa L.*), and wheat-sunflower importantly increased SOM in analogy with continuing wheat and wheat- uncultivated. Campanelli & Canali (2012), showed that experiences in horticulture under organic farming the rotations, normally applied in those systems, augment soil C amount up to now, the agricultural land usage all over semiarid regions of southern Italy were prevailed by rain fed cropping systems mainly partial on continuing durum wheat (*Triticum turgidum L., subs. durum*), winter grains in supersession with nude fallow, and fodder-based systems (Farina et al., 2013; Borrelli, 2011; Martiniello, 2011). Due to pedoclimatic conditions, CAP reform of EU adopted in the second-half of 20th century, cropping system management, and increased food and industrial uses for durum wheat these simplified systems motion few selections in terms of possible crops to be included in the rotation.

Traditionally in no-reserves farms, troth crops to be included in the wheat-based rotation were sunflower, tobacco, rapeseed, sugar beet, and legumes for grain production. Tobacco and sugarbeet, previously incentivized by CAP reformation, were completely abandoned because to economic and political reasons, respectively. The coverage of grain legumes in the rotation is still limited mainly because of higher seed costs, higher yield fluctuation risks, and lower grain market prices in analogy with durum-wheat monoculture and else subsequent refract crops.

4. EFFECT CROP ROTATION ON MANAGEMENT WEEDS AND ALLELOPATHIC

Crop rotation is the most effective method in controlling weed species, and it is more successful than other weed control methods in periodically changing the sowing and harvesting dates, phenology, competitiveness, fertilization demands and relations with weed species of cultivated plants (Torun & Uygur, 2019). Pursuant to researchers crop rotation is one of the utmost potent cultural handling techniques existent to farmers for decreasing weed seed and seedling congestions (Liebman & Dyck, 1993; Liebman & Gallandt, 1997). At the end of the studies, it was stated that the weed population could be reduced by growing different cultivars in the cultivation areas in the fight against weeds, and thus the yield of cultivated plants could be increased Liebman et al., 1998; Blackshaw et al., 2001; Buhler, 2002; Anderson et al., 2007). Weeds can be faced with an instable and mostly uninviting environment that hinders their multiplication, when rotation successions include crops that vary in cultivating and puberty dates, contesting and allelopathic specifications, and associated management practices (e.g., cultivation tillage, mowing, and grazing). Although crop rotation is a well-known and long-used way of sustaining or increasing crop yields, Pursuant to Forcella & Lindstrom (1988a), rotation of corn with soybean was also found to reduce weed seed and seedling congestions contrasted with continuing corn. More research is required to figure out factors affecting weed demography in several rotation systems and to know rotation strategies that are specifically efficacious for weed, handling.

Strategy of crop rotation is basically considerable attentions in development of supportable and environmentally safe strategies for weed rein. According to Squire et al. (2000), changes in crop rotation and herbicide usage could change the weed seed banks in cultivable soils. For controlling earnest weeds, crop rotation may be an efficacious practice because it introduces conditions that affect weed growth and multiplication, which may largely decline weed aggregation (Derksen et al., 1993; Blackshaw et al., 1994). As well as, according to Forcella & Lindstrom (1988b) after seven to eight years of weed handling the number of weed seeds was about six times greater in continuing crop than in a rotated system. Ball (1992) reported another advantage of crop rotation may be associated with a smaller chance of selective annoying weeds, because crop rotation succession too determines herbicide usage and crop rotation and herbicide can react to affect weed types. Thus, pursuant to report Walker & Buchanan (1982), the yield of rotating crops and herbicides has demonstrated to be prosperous in influencing weed crowds and improving crop production, and given the increased attention paid to agro ecosystem biodiversity, Clements (1994), reported that adopting weed handling strategies that promulgate weed types various could be cheered.

Competitive orientation towards crops is done by suppressing weeds by crop rotation and allopathy; therefore, they are adopted for weed handling in several crops (Blackshaw et al., 2002; Jabran et al., 2008). Adopting a fit crop rotation can aid in reducing weed invasion (Naeem et al., 2021; Ghosh et al., 2020). For example, Forcella & Lindstrom (1988) reported the quantity of weed seeds was at six times more than a continuing mono-cropping system than in a rotated system. So, crop rotation can be used as an efficacious ecological weed handling come close (Shahzad et al., 2016; Ghosh et al., 2020; Sohail et al., 2021). According to Jalli et al. (2021), with these descriptions, the crops included in the rotation could apply negative strikes on the growth and production of the crops addendum them in rotation in long run.

The effect of some crop rotations on weed species is shown in Table 1. As can be seen from Table 1, crop rotation is effective in preventing many weed populations.

Table 1. Negative effects of some crop plants used in crop rotation on weed species

Crop rotation systems	Weed species	References
Summer Wheat + Winter Wheat+ Corn + Sunflower	*Bromus tectorum* L., *Conyza canadensis* (L.) Cronquist, *Eragrostis cilianensis* (All) Vign. Lut. ex Janchen, *Kochia scoparia* (L.) Schrad.	Anderson et al., 2007
Corn+Wheat	*Convolvulus arvensis* L., *Cyperus rotundus* L., *Lolium rigidum* Gaud.	Koocheki et al., 2009
Winter Rye+ Potato + Barley + Alfaalfa + Flax + Fallow	*Capsella bursa-pastoris* L., *Centaurea cyanus* L., *Equisetum arvense* L., *Galeopsis speciosa* Mill., *Matricaria inodora* L., *Poa annua* L., *Raphanus raphanistrum* L., *Spergula vulgaris* L., *Viola arvensis* L.	Rahnavard ve ark., 2009
Vetch+Potato, Canola+Potato, Barley+Potato, Fallow+Potato	*Chenopodium album* L., *Amaranthus retroflexus* L.	Serajchi et al., 2013
Wheat + Corn + Soybean + Peanut + Corn	*Avena sterilis* L.	Torun, 2017
Summer Wheat +Potato Potato+Summer Barley Summer Barley+Lucerne Grass Clover+Lucerne Grass Clover+ Summer Wheat	*Stellaria media*, *Veronica* spp., *Poa* spp., *Capsella bursa-pastoris*	Melander et al., 2020

Marenco & Bastos Santos (1999), which studying to the crop rotation reduces weed competition and increases chlorophyll concentration and yield of rice, reported that 1. The usage of velvet bean or hyacinth bean in crop rotation systems declines weed competition. 2. The rotation of rice with velvet bean or hyacinth bean increases the yield of rice. 3. Nitrogen application at an amount of 26 g/m2 does not replacement the legume rotation effect. 4. Hyacinth bean cultivated in rotation with rice increases rice chlorophyll concentrations.

In another study, only maize, maize+soybean and maize+wheat+forage crop rotations were tested in tillage and no tillage conditions, and it was revealed that weed populations decreased in tilled and crop rotation fields (Cardina et al., 2002).

Coating crops are often cultivated to control erosion and, when leguminous species are used, to improve soil productivity through N fixing. Cover crops may be to use repress weeds. For sample, according to researchers, lower weed congestions were observed when several vegetable crops were cultivated without tillage in the remnants of gramineous coating crops compared to when the vegetables were cultivated in a tilled seedbed or an untilled bed without coating crop remnants (Putnam & DeFrank, 1983; Putnam et al., 1983). The researchers imputed many of this effect to allelopathic composed unleashed from the coating crops that optionally repressed weed advent.

Other data show that physical specifications of coating crop remnants may be affect weed advent. Teasdale & Mohler (1993) reported that residues of rye and hairy vetch (*Vicia villosa* Roth.) cover crops on the soil surface declined soil temperature and light transmittance amplitude enough to decline weed advent. However, that keeping of soil wet under cover crop declines could raise weed advent. According to results of field and greenhouse studies by Teasdale et al. (1991), showed that hairy vetch decline used as a surface mulch declined advent of some weed types but not else.

Cover crops that are incorporated in the soil may be affect weed advent. Boydston & Hang (1995) reported that weed congestion was declined 73–85% and crop yield was increased 10–18% when potato was grown then rapeseed (*Brassica napus L.*) contrasted with then fallow. Glucosinolate compounds released or derived from rapeseed remnant were suggested as feasible agents of weed suppression. Dyck & Liebman (1994), In a field experiment examining weed-related effects of a crimson clover (*Trifolium incarnatum L.*) cover crop and synthetic N fertilizer, reported that soil-incorporated clover remnant forcefully repressed emergence of common lambs quarters but only some declined advent of sweet corn. Nitrogen fertilizer was determining to stimulate emergence of the weed but to decrease corn emergence when clover remnant was present. The researchers came to the conclusion that use of crimson clover as a N source provided weed control benefits both as a substitute for N fertilizer and as a direct suppressant of weed advent.

5. AFFECT CROP ROTATION ON PESTS AND PATHOGENS

Among the most effective methods to control soil-borne plant malady, Crop rotation, i.e., growing different crops in different seasons in the same field (Cook & Veseth 1991). According to Hoitink & Boehm (1999), the rotation of various crops decreases the malady inoculum because to host lack or other effects of the hosts, and organic remnants that can affect the pathogens or antagonistic organisms. Garret & Cox (2006), reported that the inoculum of the pathogen is greatly declined with the length of the non-host period during the growth of a specific crop. The rotation design is significant for handling the special pathogens present (Krupinsky et al. 2002). For sample, according to Breidenbach et al. (2017), crop rotation among upland maize and wetland rice affects the root colonization by bacteria and archaea. In addition, Li (2009) reported that most researchers have suggested that the usage of agro-diversity through the growth of multiple crops can have beneficial effects on a given area of land The microbial communities in the soil and plant are also influenced by crop diversity and various crop remnants, which major affects the pests, weeds and plant malady (Hoitink & Boehm 1999; Garbeva et al., 2004). Through crop rotation a variety of pests and different pathogens can be effectively handling.

In the USA, still uses Crop rotations in agriculture, but often they are greatly simplified, as in the common corn/soybean 2-year rotation in the American Midwest. The target of rotations is still the same, nomely, to enable consecutive crops to benefit from those that preceded them and, in turn, to benefit those that pursue. According to Duvick (2007), soybeans aimed corn to escape harm from the corn rootworm beetle (*Diabrotica spp*.) by providing a year in which the field was not infested with rootworm eggs and next root-chewing larvae; thus, farmers could keep away from use of chemical pesticides to control corn rootworm.

But in recent years, biodiversity between populations of rootworm beetles has enabled some of them to wait a further season before hatching. They appear just in time for the corn crop following the soybean rotation. Else populations have developed the ability to feed and lay eggs in soybean fields, too, produce larvae just in time for the subsequent year's corn crop. Entomologists, plant breeders and farmers, now are working to devise new rotational schemes or new species of plant varieties that may be put the rootworm beetles at a new damage. Biodiversity depending in this case on whether it is in the crop or in the pest once again both aims and hinders agriculture. Duvick (2007) states that use of rotations to provide beneficial biodiversity is no simple matter thus, usage of biodiversity to profit humans (and not rootworms) requires keen biological insights and knowledge of ecological interactions at many levels.

In farming systems, crop rotations are intermediate among conventional and organic known as "confederate" or "little input", for sample the Linking Environment and Farming (LEAF) initiative (www.leafuk.org). In these, systems often involve minimum tillage and intentions are made to minimize the use of external inputs and capitalize on natural pest control with overall benefit to the environment (Jordan et al. 1997).

Crop rotation meets several goals that can be conflicting (Olesen et al. 1999). The main purpose of rotating crops in conventional arable rotations is usually to reduce the incidence of malady, pests or weeds that are hard to control with pesticides. In short rotations two or three crops are often employed. For example, in the United States the mostly of the maize crop is grown in a 2- to 3-yr rotation. In the United Kingdom, typically wheat and barley with breaks of oilseed rape, peas, beans or potatoes make up the main part of the rotation. On mixed farms, the rotation usually includes short term (2-3 yr) grass/clover leys. According to Turner (2004), contractual rotations hinge very much on maximizing crop productivity by providing abundant fertilizer and on the chemical control of pests, weeds and malady. The target of the rotation in dry land systems of agriculture, maybe to conserve water or minimize salinity problems.

Schnitzer (1991), reported protection crop rotation systems that raise an increase in organic matter and an increase of aggregate stability will maintain or improve the presence of pores for infiltration. Decaying roots, mainly those of deep rooted crops alike alfalfa and safflower, will leave channels for improved penetration. Other production practices might be, requirement in crop rotations such as crop remnant handling to ensure surface protection and improve penetration. Precaution: if a heavy rain occurs within a few hours after application, Macro pores can result in an increase of leaching of highly soluble pesticides.

There can be no mistake, howsoever, that the usage of in particular designed rotations reconciled to today's technology and economy can be cost-saving and chemical-saving (i.e., decline the requirement for synthetic fungicides , insecticides, and/or herbicides), while also protection or increasing the yields and quality of the product The principle works universal. According to Duvick (2007), in India's

Punjab State, for sample, rice (*Oryza sativa L.*) yields following potato and maize were 36% higher than when rice followed wheat, a typical two-crop rotation in Punjab.

Watson et al. (1999) reported, crop rotations are of particular importance in organic farming, therefore are a key component of successful arable systems. In organic farming systems Synthetic fertilizers and pesticides are banned. The main means, crop rotations are by which soil organic matter, soil fertility, and soil structure are maintained, and pests, weeds and malady are controlled. Stockdale (2001), reported that organic farming systems improve nutrient cycling and provide environmental benefits, including improved soil quality. Jordan et al. (1997), reported to other “little-input” systems such as confederate farming systems as well as cater environmental benefits through decreases in fertilizer, pesticide, and tillage inputs to match site and crop provisions.

For break the malady cycle in a soil profile, aired crop rotation ability to is extremely beneficial. Pathogen buildup is aided by monoculture on the same farmland. In the lack of rotation, such putridity can proliferate in the soil and outrun spreads, causing plant malady outbreaks to become more intense. The monoculture farming way could serve as a host plant for malady to prosper. Reason the pathogen cannot infect a plant belonging to a different family; the pathogen cycle is disrupted by rotations that result in the growth of a plant belonging to a different family. As a result, the pathogen population in the soil rapidly decreases. Propound the seven-year diverse crop rotation period, which includes three years of alfalfa, two years of chile pepper, and two years of cotton before returning to alfalfa. Alfalfa, chile, and cotton are three plants that correspond to a variety of crops. According to Omer (2018) et al. (2020), these three plants—alfalfa, chile, and cotton—belong to various crop families, thus they can aid break the malady cycle and boost productivity. Lupwai et al. (2006), reported that lowering weeds and illnesses, improving soil quality, and safeguarding the ecosystem by breaking the pest cycle, the DCR aids in pest handling.

According to Yang et al. (2020), by shortening the life cycles of soil-borne pathogens aligned with a species plant or crop genotype, the DCR offers a good chance for the development of certain soil-functional microorganisms. For sample, various genotypes of chickpeas (cultivars) or rotating vegetative crops (such as chickpea and pea) can affect the microbial performance of the soil as well as the yield of pulse crops and next wheat crops. Researchers reported that various plant kinds, specially, can produce remnants and root exudates that improve the diversity and efficiency of the soil's microbial population also soil C and N cycling (Gerogory et al., 2015; Feder et al., 1985). Vukicevich et al. (2016), expresses the target of DCR implementation is to increase the microbial population and soil heterogeneity. Berg et al. (2016) reported that various microbes interact with different plant roots, advancing soil quality with a wider spectrum of soil micro biomes.

6. AFFECT CROP ROTATION ON SOIL ACTIVITY MICROORGANISMS AND BIOLOGICAL CONTROLS

Aim to pathogen populations have time to decline, fit crop rotations prolongs time the time among crop types. For some malady, rotation to non-hosts for enough period of time will allow for disintegration of take over crop remnants and/or a decline in the viability of pathogen survival structures, eliminating one source of primary inoculum. The pathogens, by increasing the diversity of crops grown in a rotation, in the soil or on remnant from the prior crop usually will not defile the next crop grown. Cook & Veseth (1991), states that crop rotation can be one of the most effective biological control options available to producers. Rotations among grains and non-grains crops generally decrease malady risk from remnant - or soil-borne diseases. The inclusion of a pulse crop in rotations, especially with no tillage, raising the population and activity of useful soil organisms and minimizes the impact of grain root malady. For sample, the pathogen [Cochli- obolus sativus Ito & Kurib.; anamorph: Bipolaris soro-kiniana (Sacc.) Shoemaker] that causes common root rot of wheat (*Triticum aestivum L*.) and barley (*Hordeum vulgare L*.) is not a pathogen of broadleaf crops. Ledingham (1961) reported that in Canada following 5 yr of rotation with non-susceptible crops, common root rot severity reduced by more than 50% compared with severity following continuously cropped small grains. Good crop rotations need suitable intervals between sensitive hosts to allow pathogen populations to decline. The rotation interval for some malady is critical for successful malady management. According to researchers, the fungus with Existence tan spot on wheat [*Pyrenophora tritici-repentis* (Died.) Drechs.], survives on wheat residue, and a short break of 1 to 2 yr decreases inoculum and disease risk (Bailey et al., 1992; Duczek et al., 1999). With blackleg on canola [*Leptosphaeria maculans* (Desmaz.) Ces. & De Not.], the largest numbers of fungal spores are produced on canola residue that is 2 to 3 yr old, therefore the risk of blackleg infection is higher in canola planted into older stubble than in 1-yr-old stubble (Petrie, 1994). Holtzer et al. (1996), reported that crop rotations that maintain at least a 1-yr interval among sensitive crops aid to reduction the risk of wheat streak mosaic as long as susceptible volunteer wheat plants and grass hosts are controlled in the non- host phase. Other management practices include using planting dates that will reduce the opportunity for mites to infest the crop and host resistance. The crop residues that are available for microbial breakdown are determined by the crop rotation as well as by the of the rotation. According to Rothrock et al. (1995), nature, and size of the microbial community, determined by are the crop rotation as well as by of the rotation the crop residues that are available for microbial breakdown. Soil microbial biomass was lowest after summer fallow (Lupwayi et al., 1999) and when the preceding crop was clover red (*Trifolium pratense L.*) was greater in soils sown to wheat. Also Lupwai (1998) stated microbial diversity was higher under wheat preceded by leguminous crops (red clover and field pea) than following wheat or summer fallow. Diversity in crop rotation offers more ecological niches and encourages microbial diversity, scilicet, provides a heterogeneous food base for microorganisms. Reduced tillage, because of heterogeneous residues accumulates on the soil surface over time, helping to this diversity. According to the report Fernandez et al. (1998), both the research plots and the producers' fields showed that a rotation with a non-cereal crop for 1 yr did not always result in lower disease levels than in common or durum wheat grown continuously. Therefore, conclude that, in southwestern Saskatchewan, the best rotation to achieve a low level of leaf spot infection would involve 2 consecutive years of wheat followed by at least 2 yr of a non-cereal crop, or by a non-cereal crop and summer fallow, to allow for decomposition of wheat crop residues.

Tilman et al. (1997) stated that the intensification of conventional agricultural practices is threatening ecosystem services and agro ecosystem sustainability. This threatening, through soil erosion, agro-chemical pollution of groundwater, release of green-house gases and biodiversity loss. According to researchers, this is causing a paradigm shift toward sustainability, characterized by practices and concepts such as organic agriculture (Badgley et al., 2007), agro ecology (Rosset & Altieri, 1997; Thomas & Kevan, 1993), functional agro biodiversity (Wood & Lenné, 1999) and conservation agriculture that includes crop rotation (Hobbs et al., 2008). The historical adoption of crop rotations was largely motivated by the associated yield increase in the cash crop (Bullock, 1992) attributed to enhanced agro- ecosystem function in terms of increased soil fertility (particularly when leguminous plants are used in rotation), maintenance of soil structure, disruption of pest cycles and weed suppression (Smith et al., 2008). Soil microorganisms these processes are mediated largely through their complex biochemical processes (Kennedy & Smith, 1995; Kennedy, 1999; Parkinson & Coleman, 1991).

7. ROLES CROP ROTATION ON SOIL QUALITY

In the practice of sustainable agriculture, crop rotation is a useful technique (Shrestha et al, 2021). Diversified crop rotations (DCR) in contrast to monocultures or double farmed rotations refer to a set or multiple rotations of three or more crops (Wang et al., 2020). Andam (2016) reported that potentials of carefully selecting a crop rotation scheme including keeping long-term soil fertility, reduce trade-offs between crop viability and environmental impacts, and disrupt the weed and disease cycle process through intrinsic nutrient recycling. Diversified crop rotation method has benefits for soil quality including strengthening soil conditions and increasing system production around the world (Wang et al., 2019), therefor, for more productive agriculture diverse cropping systems are used as a promising option (Hufnagel et al., 2020). According to researcher that the soil to serve as a vital life cycle within the ecosystem and land-use constraints for keeping plant and animal growth, nurturing plant and animal health (Doran & Zeiss, 2000), and controlling or increasing the quality of water or the environment, Soil health (Van et al, 2019), or the ability of the land to sustain crop keeping evacuation soil or environmental depreciation, determines the quantity and consistency of soil-based organic meals (Acton & Gregorich, 1995). Van (2019) soil health as this is how it is defined: a soil's ability to performance and keeping ecosystem resources, or the soil's ability to enhance crop development without deteriorating the soil or damage the environment. Gerogory et al. (2015) believes that soil health determines the quality and yield of soil-based agricultural products. Studdert & Echeverria (2000) reported that after the rotation, the developing heterogeneity of the crop production system will maintain or improve soil efficiency by increasing crop ramnants and diverse root systems, also sloping up and developing microbial activity. The DCR keeps soil water protection, wet-soil aggregate balance (WAS), and soil enzymatic activities. In a variety of studies restorations of the physical and chemical quality of soil have been reported (Dick, 1984; Zuber et al, 2018). According to researchers the DCR helps in soil erosion management and crop production help (Alhameid et al., 2017) and importantly improves the soil attributes and usage water and nutrients in the soil profile to keep fecundity(Miller et al, 2003). Nonetheless, no single article covers the subject of DCR. Identify this, the target of this study is to sum up the concept of DCR, its significant, the problems of reconciling DCR in different locations, and the reasoning behind reconciling DCR for agricultural productivity and sustainability.

Crop rotation provides additional benefits for soil health functions such as aggregation that this over and above the effects of reducing weeds, disease, and insect problems. The diverse microbial community is promoted by the diversity of the root system, and this is reflected in the development of aggregates (Tisdall & Oades, 1982). Calegari & Ciucci (2010) reported that root systems of winter coating crops and the lack of soil disturbance during 19 years under no tillage (NT), contributed more to soil aggregation (>2.00 mm) than under a fallow or a conventional tillage (CT) system. Biotic and abiotic processes controls Soil aggregate formation, plays a importance role in SOC storage, providing a growth environment for the root system, and nutrient cycling (Oades & Waters, 1991). Crop rotation, which is a stimulus to facilitate biochemical and physical conditions and is responsible for the formation and binding of soil particles, these functions are affected by crop rotation. Six et al. (2000) states that soil structure is often determined by the type of vegetation system and the degree of stability and diversity of this system and is defined by aggregates and their stability. Scientists reported that the mechanisms and processes of soil aggregates of different sizes that involve biological, chemical, and physical interrelationships are well-studied and addressed by many (Tisdall & Oades, 1982; Oades & Waters, 1991). Chenu et al. (2000) states that the interaction of root systems with soil particles and production of organic compounds play a key role and this interaction through biochemical processes is essential in the rearrangement, flocculation, and cementation of soil particles, where SOC, poly-cations, clay, minerals, and microbial community. The product of biological activity consists of degraded SOM-derived materials that are resistant, the same as most organic compounds. Other organic compounds such as polysaccharides, carbohydrates, lignins and lipids in the soil environment are the product of root and microbial interaction with minerals. These are essential as binders for soil particles and aggregates. The agronomic rotation affects the processes of soil accumulation and this effect is heavily influenced by the diversity of plant community and system sustainability (Chan & Heenan, 1996). The effects of agricultural rotation are due to its rhizosphere effects, where root secretions are secreted, plays an important role in the rearrangement of soil particles and changes in physical, chemical and biological properties that lead to soil accumulation (Bronick & Lal, 2005). Soil aggregate stability and formation are highly increased as a result of an increased rhizodeposition, root turnover, root density, microbial biomass, and hyphae growth (Caravaca et al., 2002). According to Holeplass et al. (2004), the aggregate stability for meadow-based rotation can be larger than that for grain rotation, because of an increase in SOC concentration because to an increase in root biomass. In Norway, the meadow-based rotation plus grain rotation increased the percentage of aggregates distribution of the 0.6–2.0 mm and the <0.6 mm fractions, but might reduce at the 6–20 mm and >20 mm fractions. distribution and size of soil aggregates can importantly differ between various crop rotations in the top 0–10 cm of soil depth. In Norway, the meadow-based rotation plus grain rotation increased the percentage of aggregates distribution of the 0.6–2.0 mm and the <0.6 mm fractions, but may decrease at the 6–20 mm and >20 mm fractions. The aggregate stability for meadow-based rotation can be greater than that for grain rotation, because of an increase in SOC concentration due to an increase in root biomass.

Supplying the growing demand for population with inadequate agricultural resources is a major challenge on a national and global scale (Davis et al, 2016; Renard & Tilman, 2019). Due to increased food demand and lower crop yields as a result of population growth, the agricultural sector is critical in resolving the productivity crisis. For agricultural efficiency, soil texture or fertility is critical to keeping a healthy environment. In future, rising food request and a famine of agricultural land will necessitate larger soil productivity and crop efficiency (Tahat et al, 2020). Recently, specialists have become increasingly concerned about soil evacuation caused by intensive agriculturing (Khaledian et al, 2017; Mekonnen et al, 2015). An increasing interest in efficient and innovative agricultural practices has sparked a pragmatic strategy for agricultural land handling, mainly in light of the concerns of soil erosion exacerbated by anthropogenic behavior and unsustainable farming practices. According researchers reported, Since the 1950s, almost 60% of soil evacuation has been attached to various degrees of soil ecological processes, with farming practices becoming one of the main subscribers (Lal, 2015; Snakin et al, 1996). To increase farmers' understanding of agricultural activities, researchers are turning scientific information about soil into real techniques, thus gaining an important position in the global resilience of agricultural targets (Doran, 2002). One of the targets of sustainable farm management is to grow soil organic matter and reduce soil erosion through crop rotation. Crop rotation disrupts the reproduction of pathogens and insects and disrupts their life cycle. Plant nutrients are regenerated when certain plant species are included in the crop rotation and needs less chemical fertilizer.

Crop rotation methods are divers, because cover crops among both forms of cash complete root exudates and biomass to keeping the physicochemical composition of soil erosion. Crop rotation maintains soil quality through the formation and secretion or emergence of rhizospheres, the formation of flexible biological cavities, the interaction of roots and associated hyphae, or the stabilizing and destabilizing components of destruction, roots, and remnants of these plant parts. Reeves et al. (1984) reported that small and inconsistent differences in soil water table and bulk aggregates accompanying the use of crops like wheat or lupin in South Australia. Likewise, the work in Alam et al. (2014) found that following canola and lupin cropping; the soil was more permeable and had declined soil hardness. The soil have solid and more permanent particles, after harvesting diversified crop peas and barley and after their roots were accounted for the accumulation of soils and the production of macro-pore Wright & Anderson (2000) reported that the non-AMF (arbuscular mycorrhizal fungi) hosts are both lupin and canola, which makes it difficult to interpret changes in cumulative stabilization supporting glomalin development by the matching AMF regarding the recent history of other crops. In additional Ellouze et al. (2014) states that , certain non-mycorrhizal plant kinds, alike canola and mustard, might be unable to form symbiotic relationships with a specific rhizobacterial characteristic as more chemical fertilizer is needed, therefor altering the physiological soil structure and fertility in the near future.

It is obvious that soil with complete physical, chemical and biological properties improves soil quality in the agricultural system. For sample, according to researchers, a wheat-pulse crop rotation can improve soil conditions and increase system productivity. The researchers of (Tanaka et al, 1997; Wyland et al, 1996) found that a 4-year wheat-fallow field pea (*Pisum sativum*) rotation provided enough cover to hinder soil deterioration by conserving the land's physical structure. According to recorded studied by Gan (2015), diversifying cropping systems with plus crop rotation is useful to increase soil water conservation and raise the store of soil nitrogen Wyland et al. (1996) in the studies discovered that cover crops like rye and phacelia (*Phacelia tanacetifolia L.*) were successful in absorbing nitrogen and water, decreasing nitrate leaching in irrigated broccoli (*Brassica oleracea var. italica*) by 70%, and decreasing fertilizer utilization in the soil. The diversified cropping system has a number of considerable advantages that has been documented around the universe. For sample, in reported by Miller (2002) diversified cropping designs, improve water usage efficiency and grain production by combining grains with broadleaf crops. According to two universal researches conducted by (Miller et al., 2003; Gan, 2018; Li et al, 2019; Mcdaniel et al, 2014; West & Post, 2002) crop rotation diversification or better crop rotation has been linked to higher soil organic carbon (SOC) levels than monoculture. Klose & Tabatabai (2000) states that in general, the crop rotation system's different plenty, monotony, and dispersal of crop remnants chip in to higher soil enzyme activity than the crop rotation system.

Lal (2009) has been shown to High soil component quality have a positive stroke on crop productivity. Agricultures can cultivate SOC and nitrogen fixation in agricultural production processes by farming various crops in the same location (crop rotation) and also improve handling of insect, weed, and malady, decrees soil evacuation. For sample, For example, in research's by Zuber et al. (2018), two current long-term rotational tests of consistent corn, consistent soybean, corn-soybean, and corn-soybean-wheat rotation, the most diversified rotation of corn-soybean-wheat rotation increased the organic carbon capacity of the soil by 7% compared to consistent soybean, and rotational and tilling interactions with soil organic carbon were 7% greater than standard farming. The reciprocal keeping or increase of these plants' output capacities can cater an extra useful (Bullock, 1992; Brady et al, 2015). By accepting a wider variety of crops, SOC decomposition, soil combination, and texture can be boosted while production is boosted, reducing soil and environmental harm (Campbell et al., 2005; Gan, 2015; Shrestha et al., 2013). By replacing fallow periods with growing various crops that refill soil nutrients, crop rotation has aimed to increase productivity.

8. UTILIZE CROP ROTATION IN ORGANIC PRODUCTION

Conventional systems use solvable chemical fertilizers and organic production systems usage crop rotation and animal and green manures to keeping soil fertility. Organic crop rotations confine from forage-based systems with several years of alfalfa (*Medicago sativa L.*) to rotations with yearly crops only. Campbell (1993) states that it has been well appointed that the preceding crop rotation will affect the nutrient uptake, growth and nutrient amount of grain in next crops. The reason for the conflicting results between studies comparing the nutritional value of food products is the wide variety of uses of crop rotation in organic agriculture. Therefore important to contrast organic and bespoke crop production systems within the background of particular crop rotations in instruction to know the effects of both production system and crop rotation on the nutritional quality of grain.

Expositors of organic agricultures and low-input supportable agriculture advance inorganic fertilizers degrade soil. To supply nitrogen, and crop rotation, the use of legumes and pesticides and weeds are recommended. Thus, systems that rely solely on legumes to maintain soil fertility eventually become impoverished and yields are reduced because legumes do not provide phosphorus. In contrast, research by Campbell & Zentner (1993) has shown that if inorganic fertilizers are applied according to soil tests where grains are grown yearly, soil organic matter and the N-supplying power of soils are kept as effectually as when legumes are included in rotations.

In the developed countries with the development of organic agriculture, crop diversity has been re-evaluated in recent decades, since crop diversity practices can be both sustainable and profitable, and can support a wide confine of food necessarily for different consumers. Heaton (2001) reported that in organic agricultural practice, only a little (natural) fungicidal products are allowed, thus other methods of declining or repressing both senior and below-ground pathogens are required, and crop diversity can be a powerful strategy to do this request of organic production. Ecological handling system is accountable for promoting the soil biological activities, biodiversity, and biological cycles, and for providing human health benefits such as providing nutrition and declining environmental contamination. This type of organic agriculture practice known as the most supportable form of agriculture, because can keeping, restitute and aid in raising ecological harmony (Heaton, 2001). Organic agriculture can be supportable also profitable (Mäder et al. 2002). Willer et al. (2010) reported that recently, 97% of organic products are produced by the United States and Europe, and the turnover has doubled every year. The handling strategies employed recently for organic products are different from contractual ways. Letourneau & van Bruggen (2006) states that the original significant difference is the limitation of the chemical fertilizers and pesticides employed in the production system. Instead, cultural and biological approaches are used to support crops from pests and malady. Van Zwieten et al. (2004) said that a finite number of fungicides, natural products in the form of plant extracts, or biological control are allowed to be employed in organic practices but the sustainability of organic fungicides is still suspicious. For some malady, especially for soil borne malady, crop diversity in the form of rotation and intercropping are widely adopted in organic production systems. Leguminous crops are widely usages in crop rotations to keeping and increase soil fertility in cases of chemical fertilizer decline. Also, soil can be feed with organic remnants in the form of animal manure and cover crops. According to Mäder et al. (2002), the handling of organic matter is a KK practice for keeping soil fertility and sustainability. In over plus, the improvement in soil quality by researchers has also been documented (Doran & Zeiss 2000; Janvier et al. 2007). The appearing of plant malady can be considered as an index of inconsistency and an unhealthy ecosystem.

According to results of Turmel et al. (2009), the differences in the mineral composition of organic and common wheat are due to differences in crop rotation. In organic systems that combine alfalfa in the crop rotation produced wheat with N and S concentrations analogous with arbitrary grain, whiles in an yearly grain crop rotation that did not include N additions through animal or green manures, N and S concentrations in organic wheat fell short of those in arbitrary wheat. Soil phosphorus was low in organic systems where alfalfa was grown, so the amount of phosphorus in the grain was low. Crop rotation and soil nutrient status possibly by affecting mycorrhizal colonization also influenced the concentration of micronutrients Mn, Zn and Cu in wheat. Concludes that differences in crop rotation lead to differences in the mineral composition of organic and common wheat. Organic systems that combine alfalfa in the crop rotation produced wheat with N and S concentrations analogous with arbitrary grain; whiles in a yearly grain crop rotation that did not include N additions through animal or green manures, N and S concentrations in organic wheat fell short of those in conventional wheat.

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CHAPTER 3

UNDERSTANDING ORGANIC WEED MANAGEMENT

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INTRODUCTION

Agriculture begins with the cultivation of the soil (Saffeullah et al., 2021). Organic agriculture, whose history is as old as agriculture, started with agriculture in primitive times. However, mechanization and the availability and widespread use of chemicals have limited organic farming areas. As a result of excessive and uncontrolled biochemical techniques and chemical use in order to feed human beings and obtain products with high market value, there have been changes in the yield and quality of most agricultural products, and healthy food supply from soil to the table has gained more importance. In this context, organic agriculture, which prohibits the use of chemicals (pesticides), comes to the fore. Pesticides (fungicides, insecticides, herbicides, etc.) have been adopted by farmers in the 80-year period from 1920, when the use of chemicals began to become widespread in agricultural production, to 2020, due to their practicality and cheapness. Economic losses caused by diseases, insects, and weeds in agricultural production have decreased relatively. However, the residue problem in the product, soil, water, and ecology where chemicals are used has become an increasing problem day by day (Mahmood et al., 2016).

The direct or indirect threat of the use of synthetic pesticides in agricultural production areas to human health has led to the research of agricultural production systems in which they will not be used (Damalas, 2009). The organic farming system, which almost prohibits the use of chemicals, is an approach that farmers who have been accustomed to using chemicals for many years will abandon their behavior and it is known that it is difficult to change the habits. Here, both the producer and the consumer should be sensitive to the problems that may arise from the use of chemicals such as pesticides.

Organic farming basins are created in agriculture, and it is tried to raise awareness of both the producer and the consumer (Bond & Grundy, 2001). As it is known, one of the important factors causing economic losses in agriculture is weeds and their control is mostly carried out by herbicides. However, some tactics have begun to be integrated into organic agriculture. Now, not only in small areas, but also in large production farms, non-chemical methods of weed control are being tried, researched and developed in different crops. As the increase in organic farming areas will increase the use of humans and machinery to control weeds, this may indirectly mean an increase in costs. As it is known, herbicides are widely used for weed control because they are cheap and practical in areas other than organic farming areas. Principles of organic agriculture. This will be in parallel with the support of projects to be carried out on integrated weed management with non-chemical methods.

1. WEEDS

Weeds are a component of ecology and have many benefits, from phytoremediation to erosion prevention (Rafia et al., 2014; Anonymous, 2021). However, weeds are known as plants that can be undesirable and harmful in a particular situation (Abouziena & Haggag, 2016). Especially when weeds are in organic farming, their control costs increase and they limit production when they are not controlled (Gallandt, 2014). For effective weed control in organic farming, it is necessary to know integrated weed management well. In integrated weed control, the first thing to know and understand is weeds. The question of what weed is is still debated by weed scientists.

Weed is any plant that is objectionable or interferes with the activities or welfare of humans or the environment (Shaner, 2014). The term is typically applied to any plant species that often becomes a pest, such as wild oat (*Avena fatua*), and wild mustard (*Sinapis arvensis*). Weeds are undesirable because they cause economic losses in agricultural areas, disrupt aesthetics in landscape areas, can be toxic to humans and animals when consumed as food-feed, and are exotic plants in ecology (unnatural but come from other ecosystems can be invasive).

Weeds have three different life cycles: annuals, annuals and perennials (UMass Amherst, 2021). The life cycle of the weed is generally based on the agricultural product they are found in. Typically, weed species life cycles tend to mimic crop life cycles. For example, annual weeds dominate in annual crop production systems, while perennial weeds thrive in perennial crops. This is because perennial weeds cannot withstand annual tillage and other intercrop farming activities. But annual weeds germinate, striving to dominate perennial crops. The evolutionary strategy of annual weeds is to reproduce by seed. Annuals usually germinate with the crop, grow fast and set a large number of seeds (Wilson & Wright, 1990). Typically, they complete their seed-to-seed life cycle in less than half a year, with some even completing this period in a few months. For this reason, annual weeds are also called winter weeds (found in winter crops) and summer weeds (found in summer crops). Biennial weeds reproduce every two years after a vegetative wintering phase (Ito, 1992). These species are sensitive to tillage, so they are not permanent on annual crops and seed setting is not allowed on perennial crops either. In perennial weeds, since the permanent stage of the life cycle is the plant itself or plant parts such as rhizomes, stolons, tubers, bulbs, seeds are usually transient and less capable of reproduction (Miller, 2016). Most of the weeds in meadows, pastures and forests are perennial because the soil is not cultivated or deteriorated, and annuals are consumed because they are more palatable for animals. Most perennial weeds that are a problem in agricultural areas are not woody but herbaceous. Understanding life stages such as germination, vegetative growth, generative development (blooming, reproduction and seed setting) and dormancy is critical for the identification of weeds. For example, annual lambs quarters (*Chenopodium album*) tend to germinate in spring and tend to compete highly with the crop it germinates. This weed should be controlled during the early development period of the crop.

Knowing the morphology or growth habits of weeds is important for weed control (Bhowmik, 1997). When weed types are examined, vertical-horizontal, large-small, shallow-deep, pile-fringe, thin-span, self-climbing etc. their structure affects their problem posing status. The control of horizontally growing, creeping, climbing and pile rooted species may be relatively more difficult. Weed morphology plays a key role in weed management as it determines which part should be targeted in weed control (van der Meulen, 2017). Knowing the flowering, seed setting, seed pouring, dormancy, germination and other reproduction forms of weeds is important in terms of the precautions to be taken to prevent the proliferation of weeds. It is important to know and control the weed seedbank, but the plant structure must be known for the management of germinating weeds (Munier-Jolain, 2014). Therefore, it is important to have knowledge about the biology, ecology and biochemistry of weeds.

Unwanted plants seen in crop production areas are called weeds (Rao et al., 2020). Weeds in organic production areas should be kept under pressure in a way that does not harm the yield and quality of the product. There can be no thought of eradicating weeds. It should not be forgotten that weeds may have different functions in ecology. (Cerdà et al., 2021). It is known that different parts of weeds, from their roots under the ground to their photosynthesizing leaves, are responsible for ecological continuity (Gyssels et al., 2005). As it turns out, weeds have benefits and harms. Some important weeds found in organic farming areas are given in Table 1.

Table 1. Common weeds in organic farming (SARE, 2021)

Weed scientific name	**Family**	**Life history**	**Seed weight (mg)**	**Season of emergence**	**Seedbank longevity**
Amaranthus retroflexus L.	Pigweed	summer annual	0.39	mid spring	5–20 yrs
Anthemis arvensis L.	Lettuce	annual or biennial	0.5, 1.2	fall, spring	NA
Capsella bursa-pastoris (L.) Medicus	Mustard	summer or winter annual	0.1	fall, spring, summer, winter	usu. <3 mos
Chenopodium album L.	Beet	summer annual	0.7	spring to summer	several yrs
Cirsium arvense (L.) Scop.	Lettuce	perennial spreading by horizontal roots	44228	spring, fall	1–5 yrs
Convolvulus arvensis L.	Morningglory	perennial spreading by deep, creeping fleshy roots	10	fall, spring	up to 21 yrs
Cyperus esculentus L.	Sedge	perennial with rhizomes and tubers	0.17	spring	<5 yrs
Digitaria sanguinalis (L.) Scop.	Grass	summer annual	0.52	spring	1–5 yrs
Echinochloa crusgalli (L.) Beauv.	Grass	summer annual	44378	spring to summer	>4 yrs
Eleusine indica (L.) Gaertn.	Grass	summer annual	0.51	early to midsummer	<5 yrs
Galium aparine L.	Madder	summer or winter annual	44234	fall, spring, winter	up to 7 yrs
Kochia scoparia (L.) Schrad.	Beet	summer annual	0.54	spring	>20 yrs
Lactuca serriola L.	Lettuce	summer or winter annual or biennial	0.45	fall, spring	1–5 yrs
Lolium multiflorum Lam.	Grass	winter annual	2	spring, late summer to fall	>5 yrs
Lamium amplexicaule L.	Mint	winter annual	0.53	fall, spring	>4 yrs
Poa annua L.	Grass	annual or short-lived perennial	0.26	spring, late summer to early fall	>20 yrs
Polygonum aviculare L.	Buckwheat	summer annual	44378	spring	NA

Table 1. (continued)

Weed scientific name	Family	Life history	Seed weight (mg)	Season of emergence	Seedbank longevity
Portulaca oleracea L.	Purslane	summer annual	0.13	summer	up to 20 yrs
Raphanus raphanistrum L.	Mustard	winter or summer annual	8	late summer to fall, early spring	up to 40 yrs
Senecio vulgaris L.	Lettuce	summer or winter annual	0.18, 0.22	fall, spring, summer, winter	NA
Setaria viridis (L.) Beauv.	Grass	summer annual	11	throughout growing season	>20 yrs
Sinapis arvensis L.	Mustard	summer or winter annual	1.6, 2.3	spring, late summer to early fall	up to 40 yrs
Sisymbrium officinale (L.) Scop.	Mustard	winter or summer annual, rarely biennial	44317	spring to summer	<4 yrs
Solanum nigrum L.	Nightshade	perennial spreading by deep, creeping roots	1.1–1.9	spring	<13 yrs
Sonchus oleraceus L.	Lettuce	winter or summer annual	0.27, 0.34	fall, spring	up to 30 yrs
Sorghum halepense (L.) Pers.	Grass	perennial spreading by shallow rhizomes	44233	spring	<5 yrs
Stellaria media (L.) Vill.	Pink	winter or summer annual	0.35, 0.67	fall, spring	up to 20 yrs
Thlaspi arvense L.	Mustard	winter or summer annual	45658	fall, spring	up to 50 yrs
Veronica hederifolia L.	Snapdragon	annual	0.1	fall, spring	several decades
Xanthium strumarium L.	Lettuce	summer annual	small, 39; large, 54	spring to summer	>5 yrs

2. ORGANIC WEED MANAGEMENT

Weeds can be found in agricultural areas (field, vineyard, garden, meadow and pasture, etc.) and non-agricultural areas (road, railway, airport, pavement, dam, etc.) (Liebman et al., 2016). The main factors that prepare the environment for the presence and development of weeds in agricultural areas are soil and climate (Petit et al., 2011). Soils are nutrient stores for weeds, from which they get water and mineral matter (Blank and Young, 2004). Weeds have adapted to different soil structures. Some weeds are an indicator of some soil types such as pH value or moisture balance, type and amount of inorganic and organic matter, etc.), while others are an indicator that there is a problem in the soil they are in. For example, Clover - High in magnesium, low in nitrogen; Reeds- Bad drainage, and Thistle - Low copper and iron (MSU-Extension, 2016). On the other hand, weeds have adapted to different climate types such as equatorial, tropical, monsoon, desert, Mediterranean, oceanic, continental and steppe seen in different parts of the world. Of course, there may be differences in weed types and densities in products grown in forests, meadows and pastures or farms in different places with the same climate and soil structure. The main factors affecting weed diversity in agricultural areas are the crops grown and the agricultural maintenance processes applied.

Weeds shed their seeds on the soil where they grow and are carried to different areas by living and non-living factors (Travlos et al., 2020). Weeds, which tend to germinate with the cultivated plant, become a threat to agricultural production if they are not controlled. (Rahman, 2000). The interaction and competition between crop and weed starting from germination are given in Figure 1.

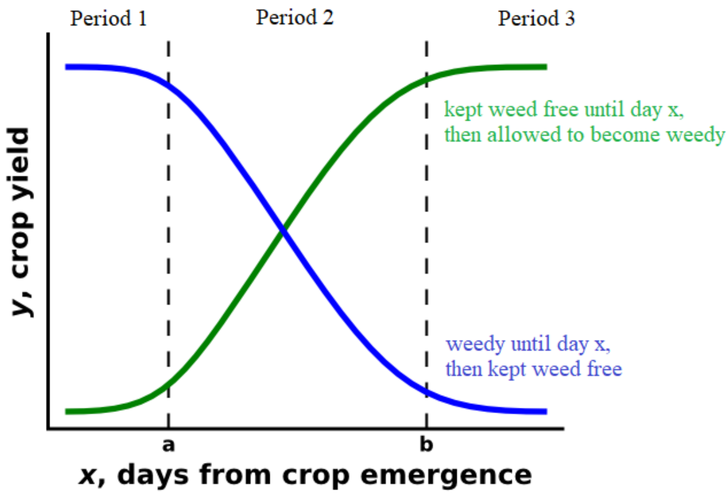

Figure 1. Critical weed-free period

As can be seen in Figure 1, controlling weeds at the critical point between a-b in the 2nd period caused the yield to be preserved. The interaction begins with the germination of the cultivated plant and weed. However, this interaction is a complex situation (Maxwell & Luschei, 2004). It is known that several weed species can become a major problem depending on the agricultural product (Ekwealor et al., 2019). For example, Poaceae family species are prominent in johnsongrass cotton, barnyardgrass corn and wild oat wheat (eOrganic, 2021). The competition for access to resources between crops and weeds is given in Figure 2.

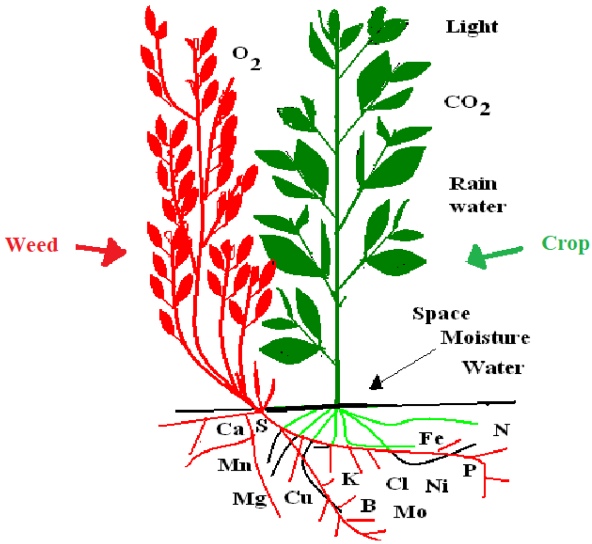

Figure 2. Weed-crop competition

As Figure 2 shows, weeds compete with the crop for water, mineral matter, light and canopy. Weeds can secrete allelopathic chemicals and slow or stop cultivar growth (Li et al., 2019). For example, johnsongrass is known to be allelopathic. Weeds can interact with soil microorganisms related to the product (Massenssini et al., 2014). The best example of this is to establish symbiotic relationships with mycorrhizal fungi. The relationship between mycorrhizae and weed is a popular topic for organic production (Francis and Read, 1995; Vatovec et al., 2005). There are many differences between organic agriculture and traditional agriculture (Gallandt, 2014). The most important difference is that almost no chemical fertilizers and plant protection products are used in organic agriculture (Zimdahl, 2011). Organic agriculture is an agricultural production method that aims to protect the health of soil, water, air and living things (Buck & Scherr, 2011). This production technique, in which agricultural production is purified from synthetic chemicals in order to preserve the ecology, is a difficult process (Liebman et al., 2001). With the simplest approach, the use of herbicides in conventional agriculture is practical and economical (Yandoc et al., 2004). However, for sustainable agricultural production, weed management methods in organic agriculture should be researched, developed and expanded.

Weeds interact with light, water, mineral matter, ground and cultivated plants to maintain their vital activities and continue their generation (Reddy, 2018). This interaction is mostly in the form of competition (Kruepl et al., 2006). In order to increase the competition of the cultivated plant with the weed, breeding and agricultural maintenance operations are carried out. Weed control is necessary because weeds cause a decrease in yield in the product. Weed control consists of recognizing weeds, knowing the seed bank, preventing the contamination of invasive species and suppressing existing problematic species (eOrganic, 2021). The problem of weeds depends on the weed triangle, which consists of the soil seed bank, suitable environment and sensitive product given in Figure 3.

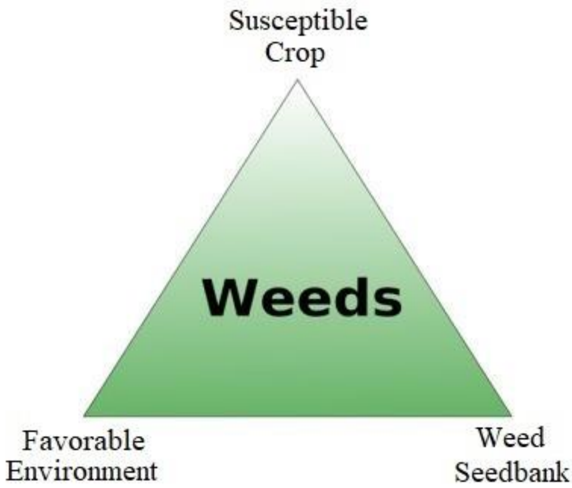

Figure 3. Weed triangle

As can be seen in Figure 3, the dispersal, settlement, germination, development and problem of weeds that cause yield and quality loss in the crop may vary depending on the crop being cultivated, the amount of weed seeds in the soil and suitable environmental conditions. If weed control is not carried out in agricultural production areas, even in meadows and pastures, weeds can become dominant in these areas and cause problems (Klingman, 1956). These undesirable plants, namely weeds, should be prevented from growing or contaminating in these places where they are not desired. There are different methods for the management of weeds.

An integrated approach that combines many tools and tactics to manage weeds is essential for sustainable agriculture (Francis, 2019). Integrated weed management is the combination of several different preventative tactics, such as viable cultural (ecological), mechanical (physical), chemical (herbicide), and biological. Selection of tolerant/resistant or competitive crops, allelopathy and crop rotation can be applied as cultural weed management. Organic weed control should be integrated into best agricultural practices. Organic weed management includes 1) cultural, 2) physical, 3) biological and 4) non-chemical alternative methods. The main weed control methods applied in organic agriculture are given in Figure 4.

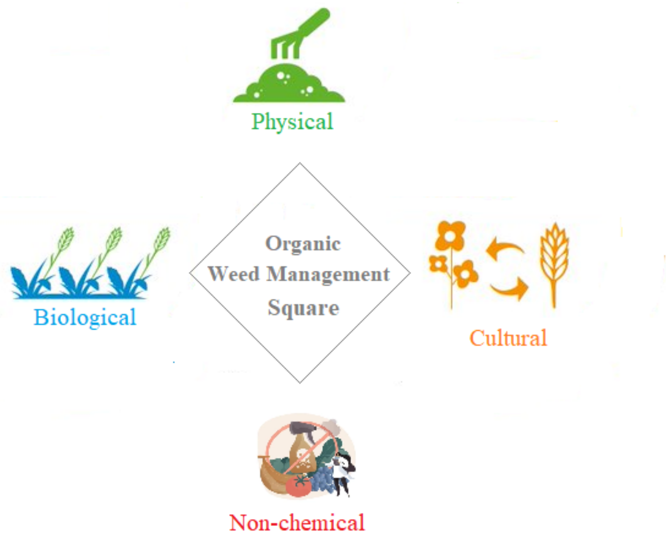

Figure 4. Organic weed management square

As seen in Figure 4, cultural processes, mechanical practices, biological methods and non-chemical alternative tactics constitute the organic farming weed management square. Organic weed control tactics can be a good approach to weed resistance management (Korres, 2018). As a general rule, over-reliance on the same herbicide mode of action increases selection pressure and can lead to the development of herbicide resistance over time (ConvisoSMART, 2021). Since synthetic chemicals are not used in organic weed management, the problem of resistance to herbicides in weeds will be completely resolved.

Including herbicides in integrated weed control can cause herbicide resistance problems in weeds (Harker & O'Donovan, 2013). It is seen that herbicides with different action sites and mechanisms have been suggested to delay the resistance problem. Not using synthetic herbicides in organic farming provides a solution to this problem.

Crop rotation as a cultural practice for weed management in organic farming is an effective practice (Gallandt, 2009). Crop rotation is practiced for weed management from the first agricultural periods until the use of herbicides. Today, crop rotation continues to be applied as an indispensable tactic in organic weed control (Merfield, 2019). However, it has to be determined by considering the crop selection and weeding situation to be grown in crop rotation. For example, in an alternation system where wheat is then grown barley, weed management is negligible. However, it will be more effective to select crops with different families and different weed management strategies. Crop rotation is an important tactic for good weed management (Bond & Grundy, 2001). For example, a weed that is a problem in a grass crop may not be a problem when a legume crop is planted. Here, both the weed competition of the cultivated plant and the applied agricultural care processes are effective.

The use of cover crops together with crop rotation is a technique that increases the weed competition of the cultivated plant (Hassas Tarım, 2021). Applications such as crop rotation and the use of cover crops do not contain synthetic chemicals, these applications can be preferred for weed management in organic agriculture.

For physical weed management, thermal techniques such as hoeing, tillage and flame weed removal can be selected (Ascard et al., 2007; Rueda-Ayala et al., 2010). Herbicides to chemical weed management are common. Other organisms such as fungi, bacteria, nematodes, mites and insects are used for biological weed management.

In recent years, different technologies such as sensitive sensors, artificial intelligence, robotics and drones have started to be investigated in integrated weed management (Esposito, 2021). In integrated weed management, it is essential to use chemicals as a last resort by combining applicable strategies to keep weeds below the level of economic damage (Wageningen, 2018). This also needs to be integrated into all other agricultural maintenance processes such as disease and insect control.

Contrary to integrated weed control, organic farming has banned almost all synthetic fertilizers and pesticides (McGuire, 2017). The use of allelopathic substances or bioherbicides obtained from other plants in organic agriculture is limited or limited. In other words, they can only be used in certain areas, in certain crops, in certain weeds, in certain periods and doses, subject to control. As it can be understood, weed management in traditional agriculture is carried out depending on chemicals (herbicides), while cultural, physical, and biological techniques, that is, non-chemical methods (without using herbicides), dominate in organic farming systems.

Another good agricultural practice is biological or biotechnical control (McFadyen, 1998). In biological control, microorganisms such as fungi and bacteria can be selected, as well as biological monsters such as chicken and sheep (Harding & Raizada, 2015).

Additionally, grazing using animals such as sheep as biological beasts may also be an option for control of grazing lands and perennial agricultural production areas. Especially in perennial agricultural areas such as vineyards and orchards, grazing with poultry or small cattle is important in terms of suppressing both weeds and harmful insects or pathogens hosted by weeds. In fact, the excrement of these animals increases soil fertility as fertilizer. However, it is an important problem to prevent the animal manure from being burned and, more importantly, to prevent animals from damaging the vines, saplings and trees in the established garden. In organic agriculture, highly competitive crops should be selected, the seed bank should be reduced, weeds in the production area should be kept below the economic damage threshold (eOrganic, 2021). The spread of weeds in the production area should be prevented. Certified seed should be used, tools and mechanics should be disinfected (Liebman & Gallandt, 1997).

3. CONCLUSION

A best weed management plan will vary with the crops being grown, the soil, the need for irrigation, available equipment, and the farmer's experience and skill (Hurley et al., 2009). Best weed management in organic farming is a combination of different control strategies with a common goal (McGuire, 2017). Synthetic chemicals have almost no place among the methods to be chosen, this is the red line for organic farming. For effective weed management in organic farms, counter-preventive measures can be taken, cultural treatments, mechanical applications, biological factors and alternative tactics can be applied.

The first way to manage weeds is preventive measures (preferring certified seed, prevention of contamination, quarantine measures, tracking of invasive species, use of disinfected equipment, burnt farm manure, controlled grazing, weed removal from the edge of the field, cleaning canals to prevent contamination with irrigation water, irrigation) to install filters in the pipes, etc.) (Webber et al., 2009). With preventive measures, weeds in the organic farming farm are kept under control and new contaminations are prevented. If possible, weed-free areas or soils should be preferred for organic farming. If this process is to be carried out in a weedy area, it is necessary to determine and record the weeds there. In general, the more weed seeds in the soil weed seed bank, the higher the weed populations in the crop are expected to be. Efforts should be made to reduce their presence in the seedbank. It should be tried to prevent the transmission of new weeds to organic farming areas. Because infected species can become established and increase the reserve of weeds in the seedbank. As it is known, newly transmitted weeds can be invasive and their seeds can remain dormant in the soil for years. Certified seeds should be used to prevent weeds from entering organic farming areas. In order to prevent contamination from the edge of the field or from the neighboring field, fences can be built on the edges of the field or weeds can be combated at the edge of the field. Organic farming areas should be monitored periodically in terms of weeds, and if new or invasive species are infected, they should be controlled in the early period. Mulching, solarization, soil disinfection with steam, mowing or grazing can be done to minimize these weeds. Another issue is the prevention of the transmission of weeds in organic farming from one area to another, and this is called sanitation. The disinfection of agricultural implements and the use of burnt animal manure for sanitation will prevent the spread of weed seeds or other production materials on the farm. Weed control should be done before the harvest, during the production phase and after the harvest. Weeding conditions should be recorded. With preventive measures, cultural treatments and physical techniques, weeds can be suppressed and thus produce high quality and productive organic products.

In order to increase the competition of cultural plants with weeds, the selection of crop varieties that are tolerant to herbicides, tall, fast growing, secreting allelopathic substances, with high soil coverage, and their spacing between rows and rows should be appropriate, sowing time and depth should be well adjusted, fertilization and irrigation need and other agricultural maintenance operations should be carried out on-site in a timely manner to increase competitiveness (Gallandt and Weiner, 2015). It should not be forgotten that there may be competition between the product and weeds, as well as between weed species. As a result of competition between weeds, some weeds remain recessive, while some weeds become dominant. However, it is known that the main problem is crop-weed competition. As can be seen, there are many agricultural application options to increase the competition of the cultivated plant with weeds in planting rotation. The first thing to be considered here is that the production area should be constantly visited, controls should be made and observations should be recorded. Afterwards, appropriate methods should be adjusted according to the weed type and density. Weed species and density vary according to the cultivated plants, and the weed emergence time differs according to each product. A wild oat germinated before wheat and barley reduces yield by 3% per day. Each cultivar has different critical periods against different weeds. For example, while the first four weeks and tillering period is critical in wheat, this is the first two weeks and pre-blooming period in cotton. One of the points that should be focused on in weed management is to know the critical periods of the crops and to take the necessary action to keep the weeds below the economic damage threshold. To repeat briefly, the competition between crop plants and weeds; It depends on many factors such as product selection, sowing date, seed amount sown, row spacing and above, planting depth, plant nutrition.

Crop rotations are another important cultural process (Gallandt, 2009). An effective rotation is important for disease and insect management as well as weeds. Crop rotation varies according to the producer, product, soil and climate and its characteristics. It should be known that the most important element when designing crop rotation for weed control is diversity. The following points should be considered for a good rotation. For less competitive varieties such as lentils, it can be included in the rotation with competitive varieties such as barley. A narrow-leaved weed can be planted after a broad-leaved weed. Broad-leaved cultivars can be planted where narrow-leaved weeds are a problem, and narrow-leaved cultivars can be planted where broad-leaved weeds are present. Crops where some weeds are dense and difficult to control can be replaced with products where such weeds are less of a problem. If parasitic plants are a problem such as broomrape in sunflower, tomato, lentil, non-host crops such as sugar beet, cotton, corn can be planted. In areas where perennial weeds are a problem, mowing or grazing can be done if crop rotation is insufficient. In this case, intensive grazing and mowing must be completed at the beginning of flowering or before setting seeds. Also, cover crops, previous crops and green manure crops can be used as an alternative agricultural techniques (Ozyazici et al., 2010; Scholberg et al., 2010; Tunalı et al., 2016; Ozyazici, 2021). Cover crops are a viable technique to suppress weeds in organic farming. When cover crops are planted as an alternative to fallow, they compete with weeds and keep them under pressure, by acting as a mulch and by their allelopathic effects, they prevent the germination and development of weeds, and compete with weeds to prevent their reproduction and spread (Mennan et al., 2020).

Manual plucking, picking and hoeing has been done since the first day of man's agriculture (Rana & Rana, 2016). Soil tillage or tractor hoeing with mechanization is among the sine qua non of today's weed control. Although mechanical weed control is perceived as weed management in the form of tillage with agricultural tools and machines (such as plows and cultivators), it has become widespread in recent years in electrical and thermal methods. Briefly, mechanical weed management methods include weed pulling, mowing, mulching, tillage, soil solarization, and fire flooding etc. techniques. The share of mechanical weed management in organic farming will increase in the future. In mechanical control, especially tillage such as out-of-crop tillage (pre-seeding tillage, post-harvest tillage, and summer fallow tillage), ın-crop tillage (post-seeding tillage and post-emergence tillage), row-crop tillage, and harvest management may cause a decrease in broad-leaf weeds such as wild mustard over time, and an increase in narrow-leaved weeds such as wild oats.

Herbicides commonly used in conventional agriculture will also be used in integrated weed management as a last resort or limited, but herbicides should not be used except when necessary to minimize herbicide use (Crop. Zone, 2021). Organic farming, on the other hand, prohibits the use of fully synthetic herbicides.

Biological control (biocontrol) is the use of the target weed's natural enemies (insects, mites and pathogens) in a way that will reduce and maintain the weed density below the economic damage threshold.

Tactics such as mowing and burning can be used as other weed control control methods in organic farming. Mowing can be effective for the control of perennial weeds by causing the nutrient reserve to decrease and depletion. In one-year and two-year weeds, both animal nutrition or green manure can be obtained and weeds can be controlled by mowing before the first flowers open or just at the beginning of flowering. Annual weeds may sprout again just below the cutting point and continue to bloom. For this reason, the height can be reduced by making the provincial shape from high and other shapes downwards. Burning weeds affects germinated weeds or seeds that have fallen to the soil surface. However, incineration should only be applied in limited small areas where it is a nuisance. Burning stubble to destroy weeds is a wrong practice. Stubble fire is based on a brief application of high heat and usually does not last long enough to kill most weed seeds. On the contrary, burning stubble can break the dormancy of some weed seeds and encourage their germination.

As a result, foreign management in organic agriculture is based on the harmonious application of various alternative methods that do not contain synthetic chemicals. It should be decided which weed control method will be applied according to the product grown, the problem weed type and the available resources. It is estimated that the share of electronically developed mechanical tactics will increase in organic farming farms in the near future.

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CHAPTER 4

BASIC PRINCIPLES OF MANAGEMENT OF SOIL FERTILITY IN ORGANIC AGRICULTURE

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INTRODUCTION

To conservation of the environment and global warming and also guarantee of food security and safety; **organic agriculture (=ecological=biological)** addresses, recently, building of soil fertility in the framework of IFOAM "Organic Agriculture 3.0 targets". Thus, "organic farming" terminology is redesigned stressing measurements against soil degradation. The meaning of this 3.0 stage of the organic farming is mainly cover "building of soil health", currently.

At first, soil fertility can be obtained basically from a successfully **"nutrient cycling"** design in farm level. Secondly, it should be considered choosing activities **"maintain rich total soil organic matter"** and **"high soil carbon credits"** which are positive initiatives of the other soil physical and physiochemical properties such as soil aggregate stability, water holding capacity, and soil carbon sequestration.

One of the fundamental strategies in organic agriculture is to build soil fertility ensuring permanent improvement in physical and chemical properties of agricultural soils. Nutrient cycling; instead of maintain soil fertility adding organic fertilisers to the soil from out of the organic farms is attracting the concerns for decades. Scientific long-term trial results should be widened locally to conclude a definite recommendation in each diverse organically managed land ecology. Plant essential nutrients can be sourced, for instance, management of soil microbiologically processes such as nitrogen fixation. The objective is to achieve as far as possible a closed nutrient cycle on the farm and to minimise adverse environmental impact in the "nutrient cycling".

The increased public concern is on climate change and measurements against global warming. Currently, the greatest effect originated from to global warming has been carbon dioxide because it holds approximately 80% of the greenhouse gases due to human activities which include agricultural production systems. If we target significant decrease of greenhouse gases in the planet's atmosphere, about 2% carbon should be mixed into the soil instantly (Lal, R., 2020). To mitigate changes of greenhouse gases in atmosphere, it is necessary to reduce or totally remove carbon dioxide in the atmosphere. Carbon storage in the soil is the most promising method to optimise carbon dioxide in the air. Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil. This may be done applying recycled organic materials such as compost, biochar, and freshly chipped plants as part of the soil organic matter.

Organic agriculture presupposes an immediate action, a prevention and lots of strategies on the management of degradable agricultural wastes which are safely distributed farm areas as soil fertility builder (Oliveira et al., 2017). The European Parliament recently released a report on a circular economy action plan of the European Union (EU) that stress strategies and various legislative proposals, including the EU fertilizer regulation (Anonymous, 2021a). This includes and pave the way of increased compost application and composting in agriculture.

Accordingly, it is important to apply high quality compost to soils that can be used instead of mineral fertilizers in "sustainable agricultural techniques", especially in Organic Agriculture (OA) and Good Agricultural Practices (GAP) (Anonymous, 2021b).

Over the last three decades, the management of organic farming has succeeded to improve several strategies on soil fertility while in conventional agriculture visible signs of negatively effects come to the fore, currently, dominantly in soil degradation. Struggling to maintain the soil fertility, among giant different amendments, only few of them have contribution to circular economy and climate change mitigation which are sourced from organic biodegradable wastes (Blum, 1992).

Composting is becoming more and more widespread in many countries regarding the utilization of artificial plant biomass originating from agriculture and in rural areas. Especially compost facilities in some critical basins have also attracted attention for compost production. Today, organic materials, agricultural producers, non-governmental organizations and other communities and municipalities make compost from wastes that cause environmental problems in disposal. It is a legal obligation to dispose of wastes within the framework of the newly enacted legislation. Composting contributes directly to recycling and provides a unique opportunity for material that is deemed useless. In this direction, the large volumes of vegetable waste in Mediterranean countries; the risk of incineration of organic wastes, especially olives and pruning wastes in vineyards, and against the risk of being idle without being dealt with and sent for recycling. Regarding the definition of the "composting" provides a way to develop an "organic fertilizer source" or "soil conditioner" (Ramos-Cormenzana et al., 1995). For instance, olive tree and viticulture have the largest amount of organic production share among the other organic plant production in the world (Willer et al., 2020). Thus, the pruning artificial parts of the plants potentially good sources both composting or else extruding and freshly use of their wood chips.

1. NUTRIENT CYCLING

Nutrient recycling mainly involves the recycling of organic residues or organic animal and plant based sources from agricultural and agro-industrial activities of farmers. It should be considered that waste material is comply with the organic farming regulations. Relevant organic sources are animal manures and biodegradable garden and processing wastes from urban and agro-industrial activities.

Off the essential plant macro nutrients nitrogen (N) and phosphorous (P) are the elements which are should be mainly focussed in nutrient cycling. Those are the components which should be managed to reduce the environmental impacts. If the N and P not properly managed, nutrient recycling may result in negative environmental impacts as nitrogen and phosphate can pollute groundwater and surface waters and ammonia and nitrous oxide may be released to the atmosphere, contributing to eutrophication, acidification and climate change. The Nitrate and water directives of the countries are the regulatory instruments that prevent and control these negative impacts of the N and P pollution in soil and water sources.

2. SOIL ORGANIC MATTER

Soil organic matter (SOM) plays a crucial role as it is directly related to chemical, physical and biological properties of the soil (Diacono & Montemurro, 2010; Murphy, 2014). It is well-known that soil organic matter has effects on water holding capacity, cation exchange capacity, aggregate stability and buffering capacity to acidification of the lands which are key factors a yielded organic crop production.

Additionally, soil organic matter also has a definite effect on the compaction and strength characteristics of soils which in combination with friability can determine how the soil responds to traffic and tillage. Moreover, soil organic matter is an important factor in providing a nutrient supply and in nutrient cycling, especially of nitrogen, but also of significant proportions of phosphorus and sulphur and other micronutrients.

Different organic matter compositions affect different soil functions. There are many possible organic sources of fresh organic matter that can be added to the soil for the creation of soil organic matter such as crop residues fruit tree pruning residuals, and forest litter. Some types of organic matter break down quickly, but others like, high carbon: nitrogen containing organic materials, take longer to degrade. In contrast to fresh plant residues or animal manure, composted or digested organic materials decompose slowly when added to soil because they have already undergone a significant amount of decomposition during the biological treatment, concentrating the more recalcitrant fraction. Many scientific reports released results that these plant sourced organic wastes can increase total soil organic matter.

Soil organic matter plays a key role in maintaining soil aggregation and aeration, hydraulic conductivity and water availability, cation exchange and buffer capacity and the supply of mineralized nutrients. Degradation of organic matter can be reduced in soil and in this ways carbon can be sequestered for longer periods.

3. COMPOST AND COMPOSTING IN FARM LEVEL

3.1. DEFINATION OF COMPOST

Compost is a stable soil conditioner produced through the recycling organic plant residues and manure as well as decomposing the lignocellulose rich material to humus, and oxygen-requiring metabolism of an organic substrate by aerobic (oxygen available conditions) microorganisms under controlled conditions. This means, compost is an organic material that decomposes microbiologically in the presence of sufficient moisture and temperature for microorganisms. One of the strategies is enhancement of “soil organic matter” in the shallow soil which is an important key factor of the sustainable farming systems and crucial factor for soil fertility (Marenya et al., 2008) is regular compost adding to topsoil layer which is approximately 0-20 cm depth and the most valuable in terms of “soil active fertility”. Thus, some essential plant nutrition elements in those initial to be recycled organic garbage are released in the soil. These organic wastes include fallen leaves, cut grass, animal manure such as cow and horse (please see organic farming law and legislations for poultry fertilisers), vegetable and fruit peels and residues from vegetable and fruit processing and conserve plants, and stubble in the fields. Since tree bark and wood parts break down and decompose, it is useful to evaluate them separately. Diseased and contaminated materials should also be removed.

Compost provides various plant nutrients and especially N (nitrogen) element to the soil, improves its physical properties, enhances air and water quantity of lands, increases water holding capacity and cation exchange capacity of soils. Compost pH is approximately 7, moisture content is between 35-50%, C/N ratio is between 8-22 and organic matter content is between 30-65%. It protects the soil, surface water and groundwater quality. It reduces the carbon footprint and reduces the release of methane from garbage. Compost is used in agriculture to the benefit of a sustainable organic matter management and plant production (Fuchs et al., 2008). Composts are used in all kinds of plant production as a plant nutrient carrier and via help of microbiota activity in soil, plant nutrients that are difficult to use by plants in the soil items become available.

3.2. BASIC EFFECT OF COMPOST IN THE SOIL

An optimum quantity and quality of soil organic matter sourced from compost maintains a well-aggregated soil structure that pave the way water infiltration and retains sufficient plant-available moisture, drains well and allows adequate soil air to reach plant roots, cope with the erosion effects of heavy rain and strong winds, requires less tillage or no-till to prepare a seed beds, and allows loamy soil texture and deep and highly extensive root development. Nitrogen, phosphorus, potassium, and some micro-nutrients are present in adequate amounts in compostable plant materials. It can be assumed from the great amount of scientific publications and data obtained from many pre-evaluation of the on-farm practiced plant based green compost quality parameters determined in laboratory analysis are approximately as follows; C:N 12-30, moisture content 50-60%, bulk density 450-600 $kg.m^3$, total nitrogen 0.1-1.5%, available phosphorus and potassium are 0.1-0.5% and 0.2-1.0%, respectively, on a dry weight basis. Flisc et al., 2009 reported that green compost $C_{organic}$, $N_{organic}$, $N_{mineral}$, P, K contents (in kg per t) (fresh substance) are 214, 6.7, 0.3, 0.1, and 4.2, while composted manure's 106, 4.6, 1.0, 2.0, 6.6, respectively.

Use of co-composted plant artificial materials as a soil amendment may reduce the need for commercial fertilizers. Using compost annually provides a slow release of nutrients. Most plant essential macro and micro nutrients in compost are bound to in organic matter. Mineralization of these nutrients depends on biological activity of fungi, bacteria and other beneficial microorganisms deserved to release an enzyme which needed to decomposition of the initial materials of compost pile, such as "cellulose" for rich lignocellulose source like tree pruning. Hence, rates deserved to of the plant nutrient decomposition from composts are anchor in temperature, moisture and oxygen inside the compost pile (Lhadi, et al., 2006).

3.3. COMPOSTING PROCESS OF AEROBIC PILE METHOD

The “open pile method” described in this chapter does not require high costs and can be done with equipment and equipment that can be found in farm conditions, which minimizes the need for different and various tools and equipment. It is an aerobic composting method. In order to make the final decision in the plan, the most suitable physical and economic method can be selected for the farm conditions. Among the multiple alternatives, the "compost that can be obtained from plant wastes in an open heap system and oxygenated environment" in this book is the most economical and ecological method for today's current conditions.

Composting is a thermophilic and controlled aerobic biodegradation of organic matter into a stable, humus-like product called “compost”. Essentially, it is obtained from the transformation of organic materials such as plant residues and animal fertilizers into a stable substance necessary for soil fertility. The material in a structure that has ended maturation with the activity of microbiological organisms under the conditions of available sufficient oxygen and moisture. It is an odourless material that has completed its maturation with the effect of temperature. In order to optimize the "microbial load" in the compost, it essentially involves the same processes as natural decomposition, except that it strengthens and accelerates the decomposition by mixing organic wastes with microorganisms that we name "activators". However, the potential benefits of composting are reducing odour, fly and other vector problems of manure and other organic wastes, weed seeds and pathogens (NRAES, 1992).

The composting process is carried out by a diverse population of predominantly aerobic microorganisms that decompose organic material in order to grow and multiply. The activity of these microorganisms is promoted by managing the carbon-nitrogen ratio (C:N), oxygen supply, moisture content, temperature and pH of the compost pile. Properly managed composting increases the natural rate of decomposition and generates enough heat to destroy weed seeds, pathogens and fly larvae.

The composting process can be divided into two main periods are;

(i) active composting and
(ii) ripening.

Active composting is the process by which two types of materials decompose. One of these is a period of strong microbial activity, during which (a) easily degradable material and (b) some of the more decay resistant material such as cellulose are decomposed.

Maturation, on the other hand, follows active composting and is characterized by lower levels of microbial activity and greater decomposition of the products of the active composting step. When it reaches its final stage of maturity, the compost is said to be stabilized (mature stable and irreversibly). The compost pile passes through a wide temperature range during the active composting period. As the temperature changes, conditions become unsuitable for some micro-organisms, while at the same time ideal for others. The active composting period has three temperature ranges.

These ranges depending on temperatures and can be defined as 3 parts;

1. At or below 25°C relatively, that is, the period in which microorganisms that are activated at low temperatures are active,
2. Before warm temperatures. It is the period when microorganisms such as yeasts, Escherichia coli are active and incubation temperature is between 25-40°C,
3. Can be defined as the period in which microorganisms that like to live above 45 ^{0}C.

As the temperature inside the pile rises, the temperature of the compost pile begins to rise. As the microbial population increases and diversifies, the temperature continues to increase steadily across the psychrophilic and mesophilic temperature ranges. Depending on the manufacturers' processes during composting, it usually takes 2 to 3 days for the compost pile to rise beyond mesophilic temperatures and reach the thermophilic stage of composting. As heap temperatures rise into the thermophilic range, the heap is covered by a diverse population of microorganisms operating at peak growth and productivity. This intense microbial activity promotes and maintains the vigorous warming necessary for the destruction of pathogens, fly larvae and weed seeds. The diversity of the microbial population also allows for the decomposition of a wide range of materials, from simple, readily degradable material to more complex, decay-resistant material such as cellulose (FAO, 1980).

Temperatures continue to rise and peak at around 65-70°C. Once this peak is reached, microbial activity begins to decline in response to depletion in readily degradable material and oxygen, or in response to the extremely high temperature that is detrimental to their function. Microorganisms degrade material by moving soluble components through body walls, as is done for simple compounds, or by using extracellular enzymes to break down the substance before it is taken up into the cell body. If the temperature gets too high, the enzymes responsible for degradation become denatured and dysfunctional, so microorganisms cannot get the nutrients they need to survive. High temperature may not be lethal to all microorganisms, but may affect their activity and also contribute to reduced microbial activity. Still other microorganisms form spores in response to overheating. Spores are the inactive form that some microorganisms take to protect themselves from adverse conditions, such as lack of heat and moisture. These spores will sprout once more when favourable conditions return. As microbial activity decreases, more heat is lost from the heap than is produced, and the heap begins to cool. As the temperature cools from thermophilic levels, different microorganisms migrate from colder spots to relive the pile, while spores sprout as conditions become more efficient for survival. These microorganisms serve to perpetuate the decomposition process. The compost pile remains in the thermophilic range for 10 to 60 days, depending on the treatment. When the temperature drops below 40°C, the ripening period can begin or the heap can be aerated to reactivate active composting. At no set point was active composting complete. Heap conditions are generally considered complete when the microbial activity cannot increase sufficiently to reheat the heap. This usually happens when the temperature drops below 40°C (Dougherty, 1998**)**.

Maturation occurs with a lower level of microbial activity and is responsible for stabilizing the products resulting from the active composting period. Stabilization includes further decomposition of organic acids and decay-resistant compounds, formation of humus compounds and formation of nitrate. Another benefit of ripening is that some fungi begin to live in the pile, adding to the disease-preventing qualities of the compost. Because microbial activity is reduced and operating at a lower level, very little heat is generated and the heap temperature continues to drop or remains at a low level. Proper moisture and oxygen management is still required during the ripening period to maintain microbial activity. Management is also necessary during the ripening period to ensure that the pile is not decontaminated with weed seeds. That is, to obtain a weed-free compost requires good management before composting, during material collection and during composting. For example, when creating compost, the materials that make up the pile are not put infested with plant material contaminated with weed seeds. This may require covering or repositioning the ripening piles to reduce the potential for decontamination. The reactions that occur during ripening are relatively slow and therefore require sufficient time (FAO, 1980).

Length of composting time depends on the parameters as follows;

- composting method,
- Raw material type and C/N ratios of raw materials
- the average C/N ratios of the mixed materials
- to balance the oxygen and moisture balance in accordance with the demands of beneficial and rotting microorganisms.
- To follow the humidity and temperature data during composting and to perform the mixing or moistening of the compost in a timely manner.
- intended end use of compost

Compost will be ready in 6-9 months using open pile method. Materials possible are mixed fresh green and brown wastes can be used. The brown, woody structure of excess waste needs to be balanced and sufficient water and oxygen existence input should be provided.

Current legal regulations in Turkey regarding temperature require compost to be exposed at 70^0C for at least 1 hour. In fact, the temperature of 65-70 ^0C in the core region of the compost pile is important to reach the ideal compost. Monitoring the heat stack and moisture are very important to achieve a quality compost. Converting the heap to oxygen entrance into pile or irrigate are essential after the temperature and moisture measurements of compost heap. Interventions in mixing the heap and reaching the ideal material can be eliminated by monitoring the changes during composting.

In addition, if animal manure is not to be used, commercially available “microbiological ready-made cocktails” as activators can be recommended as an effective method to obtain high quality vegetable waste compost in a short time. Cutting, chopping and crushing plant waste will increase their surface area and accelerate decomposition. However, cutting too much creates excess moisture and undesirably causes the risk of sticking and triggering an anaerobic environment.

Mature compost is a dark brown, easily dispersed, earthy, humus-like material. Having passed through a 2-5 mm sieve provides an advantage in use and increases its quality. The most distinctive features in composts that have not yet completed their maturity are; (i) continued burning (temperature rise) and (ii) the presence of odour.

The location and direction of the compost pile, ground condition, exposure to wind and sun exposure, and the use of cover throughout the process are the issues that have a significant impact on achieving quality compost in applications. Some chemical (macro (N, P, K, Ca, Mg) and micro (Fe, Cu, Zn, and Mn) element contents) and physical properties (pH, organic matter, water-soluble total salt, lime, cation exchange capacity) of compost quality in the final product. It is important to test its phytotoxic (plant-damaging) properties by considering the cation exchange capacity the C:N ratio of the compost. The application doses of the compost to the soil must be determined by the subject experts after the soil analysis. Mixing the compost by distributing it evenly on the soil is an important factor affecting plant yield and quality in agricultural soils.

4. CONCLUSIONS

Maximizing "carbon sequestration in agricultural lands" which mitigate the potential contribution to Climate Change and Global Warming is a basic principle of the agroecological farming. Thus, nutrient cycling from organic biodegradable wastes to a mature compost and ensuring soil organic matter is a deserved strategy in soil management in organic agriculture.

The compost product obtained as a result of composting will be beneficial as a soil conditioner as well as containing the plant nutrients needed by the plants. Organic wastes are valuable in terms of productivity and plant nutrition. Many agricultural wastes, from animal manures to walnut and chestnut wastes, from vegetable wastes to corn and sunflower stalks and tea waste, can be composted using aerobic pile method and used as soil physical and chemical improvers and for the nutrient needs of plants. Soil is the most important source like a "bank" of the essential plant nutrients which have already existing in the organic and inorganic substances of the soils. Thus, compost is the key factor to make essential macro and micro plant nutrition elements available in the plant root area.

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CHAPTER 5

IMPORTANCE OF INTERCROPPING IN ORGANIC FARMING

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INTRODUCTION

In commercial agriculture, pesticides, herbicides, and artificial fertilizers are used to control pests and insects and enrich the soil, and the remaining material can cause several problems after entering the body. The uncontrolled consumption of fertilizers and pesticides caused water pollution, soil and air. Use of fertilizers and pesticides cause resistance in pests to toxins, causing new pests to appear. The provision of food should be made at the forefront of plans and environmental protection should be a major priority.

Organic farming conforms to the sustainable development of farming and is a collection of activities aimed at controlling the consumption of chemical inputs. Organic farming is excluded from the use of fertilizers and pesticides, preservatives, chemicals, genetically modified organisms, and sewage.

Studies show that the global adoption process is promising, due to increasing concerns about the pollution of basic resources, food, human and animal health and more attention to the values of nature and natural landscapes.

Although in organic farms, agricultural yields are typically 10-30% lower than non-organic farms, but with proper planning, efficiency, production and income of organic farms can be higher than non-organic farms.

Organic farming is trying to free itself from organic farming compounds that depend on industrial farming using the findings of life sciences in the form of advanced techniques and helping to improve the quality of agricultural and soil products.

Organic farming is a method that considers the security of humans, ecosystems and soils. In organic farming, water is not contaminated with polluting chemicals such as synthetic fertilizers. Organic farming aims to balance the ecosystem and soil fertility. In organic farming, soil erosion is reduced by 50%. Farmers are also not exposed to pesticides and chemical pollutants.

Organic farming has many social benefits, in addition to environmental and economic benefits, and increases job opportunities by relying more on the workforce. One of the ways that brings us closer to achieving sustainable agriculture (food supply while maintaining a natural environment) is intercropping. It is mainly used in small farms and depends on the culture of agricultural labor.

Today, by doing intercropping, it is possible that an important step towards designing sustainable agricultural ecosystems and achieving sustainable agriculture is by increasing biodiversity, while it improves the quantity and quality of products and reduces the usage of outside inputs. Studies have proven that pests and diseases reduce the plant function significantly, so one way to increase crop performance is to minimize the pest population. Because of the fast impact, chemical pesticides are always the easiest way to control the pest population.

Researchers are always looking for alternatives because of the harmful effects of chemical pesticides on agricultural products. Intercropping is an eco-friendly solution due to variation of vegetation and maintenance of different species of insects.

1. ORGANIC FARMING

Due to the increasing population of the world, today the agricultural sector has become highly dependent on the consumption of chemicals to provide the food needed by the population.

Energy consumption in today's farming has increased dramatically. Machinery, fossil fuels, fertilizers and pesticides have spent more energy in agriculture, which, in addition to lower energy consumption efficiency, causes problems for human health and the environment.

One of the main reasons for soil degradation and erosion is the excessive use of chemical fertilizers and pesticides in the agricultural sector.

The rise in the consumption of fertilizers and pesticides in the production of agricultural products has led to a reduction in soil fertility, the risk of health and air, water and food pollution as well as concerns about the global environment.

The increase in production has caused several environmental problems such as pollution of water and soil resources, the emergence of new plant pests and diseases, malnutrition and disease resulting from a reduction in food quality. That is why the international community is trying to find appropriate solutions to these problem and move towards sustainable agricultural systems.

Studies show that humans have a great impact on global climate change. Increasing the concentrations of greenhouse gases create climate change. If the concentration of greenhouse gases continues to rise in this way, the average global temperature will rise dramatically in the future. Agriculture is also causing climate change. The agricultural sector emits important greenhouse gases such as nitrous oxide, methane and nitrogen dioxide and carbon dioxide, resulting in global warming. The uncontrolled consumption of fertilizers and chemicals, fossil fuels, agricultural soil management, livestock manure management, and burning of organic remains are the most important sources of greenhouse gas emissions in agriculture. Agriculture is also one of the sectors affected by climate change. Farmers are not capable of controlling climate conditions but with a shift in agricultural management and using innovative technologies, they can reduce the detrimental effects of climate change on growth, development and performance of agricultural products.

One of these strategies is organic farming, while protecting soil fertility is to increase crop production with the least reliance on the use of chemicals. In this agricultural system, artificial inputs such as chemical fertilizers, pesticides, veterinary drugs, genetically modified plants, preservatives, additives and radiation are not used. In fact, organic farming is a system of integrated, systematic and humane agricultural production that uses the available resources on the farm, strengthens the health of biological ecosystems, soil biological activity and biological cycles.

Findings from Wall et al. (2005) show that high cost, uncertainties from licensing, lack of marketing information, lack of information related to price, lack of information, lack of information, high cost of manpower, production problems is one of the main hindrances to the process of producing organic products. Schneeberger et al. (2002) showed that the technical issues in farming and the required manpower are the most serious obstacles to organic farming.

In this type of agricultural system, the main goal is to prevent the entry of all chemical and artificial substances, including agricultural pesticides and chemical fertilizers into the farm. In fact, in organic farming, the recycling of nutrients from within the farm is important.

We have no choice but to use organic farming to produce healthy and clean products and, as a result, healthy and lively human beings. The goal of organic farming is to produce a healthy crop rich in healthy foods, so that the use of pesticides and chemical fertilizers in them is minimized and biological methods are used instead of pesticides and herbicides.

2. INTERCROPPING

Agriculture plays an essential role in the existence of human society because it provides food, natural fibers, fuel and some raw materials for industry and ecosystem services.

In today's agriculture, the use of mechanization, the use of chemicals and monocultures has become more common. One way to provide food while preserving the natural environment is intercropping. Intercropping is the cultivation of two or more two crops adjacent to each other, and its most common goal is to increase the yield of two crops, which cannot be achieved in crop separately. One of the advantages of mixed cultivation is that the land is prepared once for planting, but several different crops are planted.

Intercropping means growing more than one plant in a field in one crop year. So that a plant has its maximum growth period in the vicinity of another plant and there is no need for these plants to be planted and harvested at the same time, but a plant can be planted at the same time or sometime after the first plant and harvested at the same time or before or after it.

Simultaneous planting of several crops and at the same time saves water consumption because the mixture of plants with shallow and deep roots causes them to make maximum use of water and moisture in different soil layers. Also, in terms of nutrients, one plant may use the surface layers of the soil and another plant may feed from the lower depths of the soil.

Intercropping also prevents the entry of insects or pests. For example, at the same time as planting the main crop, another plant is planted that repels insects. Mixed cultivation prevents weeds from growing on the farm because the vegetation is so large that there is no extra space for weeds to grow, which reduces the cost of spraying and controlling pests and diseases.

In intercropping, the potential risks are reduced and the soil fertility is increased, and natural resources are used to the maximum. In this method of cultivation, the use of plant pesticides and chemical fertilizers is reduced and as a result, the amount of environmental pollution is reduced.

In grass-legume intercropping, the relationship between the two species improves the quantity and quality of forage. Intercropping increases crop production using the time factor and also increases the diversity of species and thus reduces the consumption of inputs. Therefore, intercropping is a way to get closer to sustainable crop systems.

In addition, legume plants benefit non-legume plants in the intercropping system through nutrient sharing, activation of soil biological activities, and greater use of available resources. The adoption of Green Revolution technologies led to the destruction of natural resources, reduced yields or stagnation of major crops.

Today's monoculture systems have economic benefits in the short term, but they pose many environmental problems. Due to the monoculture, plant diversity has decreased and this has put food production at risk.

Intercropping can be implemented when it is economical and solves environmental problems. Also, there should be a suitable market for selling mixed crop products that are in line with organic farming so that the products can be offered at real prices.

At present, the interest in organic products has increased and for this reason, organic agriculture has received worldwide attention. Also, organic farming provides stability in agriculture. Intercropping can be used for healthy crop production and stabilization of agro-ecosystems.

In today's farming systems, where only one plant is grown on a farm, different chemicals are used to increase production to meet the nutritional needs of the people, and therefore a lot of money is spent to supply inputs to the farm. The system is highly dependent on fossil fuels. Although production has increased, humans have created various environmental pollutants with their own hands, reducing biodiversity in agriculture, and increasing greenhouse gas emissions, which in the future could make life difficult for living organisms.

Intercropping increases on-farm species diversity. Intercropping makes good use of available resources, balances ecosystems, increases the quality and quantity of agricultural products, and minimizes damage from pests, diseases, and weeds.

Bilalis et al. (2010) tested a mixture of corn and legume to investigate the effect of intercropping on weeds. Cultivation of the desired mixture increased leaf area index compared to monoculture. In this experiment, increasing the leaf area index reduced the amount of light available to the weeds and therefore the weed population decreased.

The farm should be managed in such a way as to create numerous food sources to attract beneficial insects and pest predators, which is necessary to increase the diversity of species through intercropping. Sunflower is one of the most suitable plants for attracting pollinating insects such as bees or as a prey for insect pests. According to experiments, if sunflower is grown between rows of vegetables, it can attract beneficial insects to the field. Intercropping of medicinal plants with other plants can be effective by reducing the use of pesticides and pest control by natural enemies and other favorable environmental methods.

2.1. Types of Intercropping

The goal of intercropping is to produce healthy agricultural products to feed the human population with less energy and cost.

In intercropping, plants are present in a field for most of the growing season. There are several plant species such as cereals, legumes, oilseeds, forage plants and medicinal plants that can be used in intercropping. In intercropping system, resources are best utilized compared to pure communities.

A prominent feature of intercropping systems is the increase in diversity in terms of habitat structure and plant species, this makes intercropping systems more similar to natural plant communities.

(a) Mixed intercropping

In this method, crops are not grown in specific rows. In this method, two or more plants are planted in a plot of land at the same time in a non-row and spraying manner. In this method, the seeds of plants can be combined and then planted, such as planting cereals with alfalfa or clover.

(b) Row intercropping

In this planting method, usually one row of the first plant and one row of the second plant are planted. In this method, the use of machines is difficult, so this method can not be used on a large scale. In this method, the two species are closely related and interact with each other. Row intercropping is most beneficial when a tall plant is planted with a dwarf plant, as well as plants that grow differently.

(c) Strip intercropping

Each plant is planted in several rows or in a strip, and at the same time on a plot of land. Strip cultivation creates suitable conditions that increase the yield of two plants with different heights.

(d) Relay intercropping

In this method, different seeds are planted consecutively in a plot of land in one crop year, but the seeds of each plant are sown before the previous crop is harvested.

In intercropping, the choice of plants is of particular importance. If the interaction between intercropping plants increases the yield, intercropping will be useful. If plants in intercropping have different physiological and morphological characteristics, they will use better environmental resources. Below are some of the beneficial effects of intercropping to achieve organic farming:

2.2. Impact of Intercropping on Pest Management

In today's monoculture systems, pesticides are often used to control pests, which have a negative impact on the environment, biodiversity, animal and human health. The use of pesticides in the field causes pest resistance and the spread of secondary insect pests, which also causes more damage to the crop. Conventional agriculture depends on chemicals that simplify agricultural ecosystems.

In order to control pests in an environmentally friendly manner, an agro-ecosystem must be considered that can control pests. If the right intercropping is selected, pests can be prevented and a marginal plant can increase the enemy's natural activity.

Intercropping is a solution to control agricultural pests. Intercropping is a tool for integrated pest management (IPM). Due to the negative effects of pesticides on human health and the environment, and resistance to pesticides, there is great interest in intercropping to control pests.

In order for intercropping to be able to perform well in pest control, it depends on the choice of plants and the value added after harvest, the knowledge of farmers and the mechanized methods used.

Damage caused by pests and diseases in intercropping due to the uptake of pests or pathogens by the second plant is less than pure cultivation. Intercropping reduces plant diseases and pests by reducing host plant density, changing host quality through plant-plant interactions, and increasing the population of natural enemies.

The results show that intercropping can reduce the use of pesticides in wheat fields. The usefulness of intercropping versus simple cultivation in terms of pest control is based on the following two hypotheses:

(a) The enemy hypothesis, states that in more diverse systems, the natural enemies of pests increase and this can reduce the number of pests.
(b) Resource concentration hypothesis, which states that when the system has plant diversity, insect pests have difficulty finding the host plant and have a negative effect on the persistence of pests in the habitat.

In a single culture system, natural pest enemies need more prey or hosts to complete their life cycle, and therefore do not succeed. Therefore, by increasing the number of plants and providing nectar and pollen, parasitic reproductive power and the number of alternative hosts / prey can be increased when pests are low.

In an experiment by Sidauruk et al. (2015), the effect of intercropping system on the dynamics of green peach aphid (*Myzus persicae* Sulzer) on organic potato cultivation was investigated. Mixed cultivation of potatoes with mustard, potatoes with cabbage and mustard, and potatoes with celery reduced the aphid population over two seasons.

The population of natural enemies of Braconid bee was observed in the seventh week in mixed cultivation of potatoes with cabbage and the maximum population of Coccinellidae was observed in mixed cultivation of potatoes with cabbage, mustard and celery in the eleventh week.

In the experiment of Francis et al. (1978), mixed cultivation of beans and corn reduced the damage caused by winter moth larvae. Cai et al. (2010) examined the cultivation of cabbage-garlic mixture. The results showed that in intercropping, the population of insects, especially beneficial insects, increased and as a result, intercropping increased the species diversity index compared to pure culture.

In another study by Lenardis (2011), mixed cultivation of *Glycine max* and *Artemisia annua* increased the population of natural enemies and reduced the population of pests compared to pure cultivation.

Nasab et al. (2013) found in intercropping of wheat and rapeseed, diversity increases, microclimate improves and natural enemies gain more access to food resources and damage caused by green wheat aphids and plant mites is reduced.

The results of the studies of Afrin et al. (2017) show that in intercropping of mustard plant with onion, garlic, radish and coriander plants, the number of pests is reduced. On the other hand, intercropping of mustard with wheat and gram increased the pest number. In fact, not all plants are suitable for intercropping. Cultivation of mustard mixture with onion and coriander reduced contamination of branches, flowers and increased pod formation.

Today, due to continuous spraying and the destructive effects of chemical pesticides, it seems that the cultivation of medicinal plants along with other plants, in addition to changing the insect population and providing shelter for natural enemies, will reduce the pest population. Also, reducing the pest population increases the yield of plants in intercropping. As a result of intercropping, the synthesis of secondary metabolites, including essential oils, is increased, which leads to the attraction of beneficial insects. On the other hand, cultivating two plant species together and increasing the density of different plant essential oils in the environment will confuse pests and their lack of proper access to the host plant.

Azimi & Vaez (2019) findings show that the maximum aphid population was observed in pure bean cultivation and the minimum aphid population was observed in intercropping of 50% marigold and 50% bean. The number of natural enemies was higher in row crops. The results showed that plant species richness increases species richness and insect abundance.

2.3. Impact of Intercropping on Diseases and Weeds

There is a lot of reliance on herbicides in conventional agriculture to control weeds. Excessive use of herbicides has also led to herbicide resistance in weeds, increased agricultural production costs, and also led to environmental pollution (molder). For these reasons, it is necessary to use herbicides rationally and to use integrated methods to control weeds. One of the important solutions in this field from the perspective of organic agriculture is the use of intercropping of crops. In intercropping, as the vegetation increases, the initial competition increases, the weed density decreases significantly, the weed density decreases significantly.

In intercropping, due to the increase in canopy, shading is done and this causes the weeds to be suffocated. Allelopathy in some mixed crops can also inhibit weed growth. Therefore, intercropping does not lead to environmental pollution.

Therefore, intercropping is able to reduce the use of herbicides and reduce production costs and prevent environmental pollution. In intercropping, species diversity increases and production can be increased.

In order for mixed cultivation to be beneficial, it is necessary for the plants in mixed cultivation to have different physiological and morphological characteristics so that they can make the best use of the resources available in the field and have positive interactions with each other.

Studies by Ronald & Charles (2012) show that in maize and pumpkin intercropping, when the number of pumpkin plants increases, weed biomass decreases and pumpkin plants have been able to prevent weeds from growing by shading.

In the experiment of Ghanbari & Sinch (1984), It was observed that in the intercropping of sorghum with legumes, the amount of light received increased and this issue prevented the growth of weeds.

In intercropping, if the height of the plants is also different, for example, one species is tall and has vertical leaves and the other species is short and has horizontal leaves, the light absorbed by the intercropping canopy will be more.

Disease control through intercropping can be due to changes in wind, rainfall and vector dispersal, changes in climate such as temperature and humidity, changes in host morphology and physiology; and direct control of pathogens. The effect of intercropping on host density is a factor in many of these control methods.

In an experiment by Fininsa (1996), the effect of bean-corn cultivation on bacterial blight and rust was investigated. Row intercropping and mixed intercropping reduced diseases compared to monoculture. Mixed intercropping reduced the severity of bacterial blight and rust diseases compared to row intercropping and monoculture.

In a study of intercropping of legumes and cereals by Hauggaard-Nielsen et al. (2008), it was observed that intercropping was able to control weeds and make more use of resources. Intercropping systems also reduced disease severity compared to monocultures.

2.4. Impact of Intercropping on Biodiversity

Modern agriculture has inadvertently reduced the biodiversity of farms, regardless of the consequences, and has eliminated many plant species, pollinators, predators, and soil microorganisms from the production cycle and It has turned to chemicals to replace the removed biodiversity functions. Elimination of biodiversity has caused instability in agricultural ecosystems.

Ecosystem services include processes that ensure the survival of humans through natural ecosystems. Due to the fact that intercropping is a natural ecosystem, it can improve ecosystem functions.

If suitable plants are selected in intercropping, they can provide suitable habitat for a variety of soil organisms and increase biodiversity. Natural ecosystems are usually diverse and stable, and include a variety of plant species, birds, insects, and microorganisms. Biodiversity on the farm can create sustainable agro-ecosystems.

Today, intercropping can improve biodiversity, and by increasing the quantity and quality of crops and reducing the use of chemicals, sustainable and organic agro-ecosystems can be designed. Increasing diversity through intercropping can improve ecosystem performance. Tang et al. (2014) showed that intercropping of plants increases diversity, thus increasing the population of soil microorganisms and, consequently, the microbial activity of soil.

Soil microbes establish the circulation of nutrients in the soil and play an important role in providing nutrients to the plant. There are many micro and large organisms in the soil that release nutrients into the soil by decomposing organic matter such as plant and animal debris.

Pollinators form a major part of global biodiversity and provide important ecosystem services for the production of many crops. The abundance and diversity of pollinators has decreased in recent years. Increasing flower resources in the environment can reduce this decrease. For example, researchers' findings show that cowpeas can be used to improve pollination efficiency. Intercropping of pollinator-related crops with cowpeas such as Penny Rile, Dixielee and Whippoorwill not only provides resources for pollinators, but can also increase pollinator numbers and activity to increase crop yield.

Hauggaard-Nielsen et al. (2006) in their study stated that in the intercropping of some plants with legumes, nitrogen fixation is done by members of the legume family and this increases the fertility of the soil. Legumes are important both in terms of forage production and their roots go deep into the soil, causing the proliferation of microorganisms and increasing soil volume and regulating soil acidity.

2.5. Intercropping and Food and Environmental Security

Due to the fact that the population is increasing and access to agricultural lands is difficult, food security is of great importance and is a threat to human beings.

Modern agriculture is based on the influx of chemical inputs and exorbitant costs, which have upset the ecological balance and degraded natural resources, and therefore have not been able to guarantee sustainability.

Extensive energy consumption in agricultural systems is due to the use of agricultural implements, artificial fertilizers and pesticides and hybrid seeds.

On the other hand, in intercropping systems, a variety of crops are planted and the consumption of inputs is minimized and the quality of the agro-ecosystem is improved. Intercropping can improve yields, increase production sustainability, reduce environmental residual pollution, and provide more ecosystem services.

Today, production systems with low input and low energy have become more important. In intercropping is one of these systems. In intercropping, the goal is to establish biodiversity and sustainability, and strive to make good use of resources and increase soil fertility. Studies show that intercropping increases energy efficiency, energy profitability and overall yield.

Food security must be a global concern to ensure the health and sustainability of communities. Due to high consumption of fertilizers and chemical pesticides, the world is facing climate and soil pollution. Due to high consumption of nitrogen fertilizers, removal of vegetation and increased retention of ruminants, global greenhouse gas emissions have increased. Intercropping is able to increase crop yields and food production and minimize greenhouse gas emissions. When one plant has the best growth at the beginning of the growing season and the other plant grows best in the middle of summer, the usefulness of intercropping is evident. These differences lead to greater utilization of sources such as light, water and nutrients, resulting in increased performance.

Plants such as cereals have more dry matter and less protein, but legumes are rich in protein. Therefore, the use of cereals and legumes in the intercropping system can produce high quality forage (contras). Cereals with legumes intercropping are an environmentally friendly method that can improve the quality and quantity of forage. Chen et al. (2004) reported that mixed barley cultivation with chickpeas increased yield and increased forage protein compared to pure barley cultivation.

2.6. Impact of Intercropping on Global Warming and Carbon Sequestration

Modern agriculture has tended to use fossil fuels to increase agricultural production and feed the human population. This factor has led to an increase in greenhouse gas emissions and consequently global warming. The average concentration of carbon dioxide in the atmosphere has increased to 401 ppm and is expected to reach 500-1000 ppm by 2100. Therefore, it is necessary to consider a type of agriculture that can use more carbon dioxide in the atmosphere and emit less carbon dioxide.

In conventional agriculture, we can get more yields, but conventional agriculture now requires more energy and cost, and emits more carbon dioxide. The release of carbon into the atmosphere causes climate change. Chapagain & Riseman (2014) examined chickpea and barley intercropping. Intercropping increased the amount of nitrogen, barley grain protein and also increased the amount of carbon sequestration in the soil. Due to intercropping, the levels of biological nitrogen fixation and pea nodulation increased. In addition, intercropping increased land productivity.

Studies by Chai et al. (2014) show that the corn plant emits more carbon into the atmosphere when grown alone. But wheat-corn and chickpea-corn intercropping emit less carbon than individual corn crops. Wheat-soybean intercropping also showed the lowest carbon emissions among planting systems. Hu et al. (2015) also showed that the carbon emission in the wheat-corn intercropping system was lower than that of corn alone.

These results show that if intercropping systems are selected properly, it can reduce carbon emissions and intercropping of cereals with oilseeds or legumes can prevent global warming due to agricultural activities.

It is true that nitrogen fertilizers are very necessary to increase the yield, but excessive consumption of nitrogen fertilizers has caused environmental pollution, wasted resources and reduced nitrogen use efficiency. Nitrogen fertilizers are lost due to evaporation in the form of ammonia, leaching in the form of nitrate and release into the atmosphere in the form of nitrogen oxide, which leads to the destruction of ecosystems and environmental pollution. When nitrogen is lost through leaching, it can cause eutrophication. Intercropping can reduce nitrogen consumption and therefore prevent nitrogen release from the field.

In a mixture of legumes/non-legumes, legumes provide biological fixation of nitrogen by rhizobium bacteria, and non-legume plants also use mineral nitrogen.

Do et al. (2020) showed that in a relay intercropping system of corn and soybeans, if nitrogen consumption is low, it is stable and environmentally friendly. Nitrogen fertilizer was used more efficiently in situations where nitrogen consumption was low. Relay intercropping system improved nitrogen fertilizer application. Biological fixation of nitrogen by soybeans in intercropping reduces nitrogen consumption and promotes soil fertility.

Lu et al. (2016) showed that more nitrogen intake increases nitrogen oxide emissions. If less nitrogen is used, sugarcane-soybean intercropping will be able to maintain crop productivity and reduce the use of chemical fertilizers.

In the study of Shen et al. (2018), intercropping of corn and soybean had less nitrogen oxide emission and less nitrogen fertilizer losses compared to sole corn.

The results of Pelzer et al. (2012) show that cultivation of chickpea-wheat intercropping is a suitable strategy for cereal production. In this study, intercropping of chickpeas and wheat reduced energy consumption compared to sole wheat. Intercropping maintained wheat grain protein content, stabilized nitrogen, and reduced pesticide use.

2.7. Impact of Intercropping on Soil Health

When we talk about soil health, it means that soil has the necessary capacity to function within the ecosystem, to be able to maintain the productivity of plants and animals, to create stability, and to ensure human health. Because mixed cultivation methods reduce chemical pollution, prevent soil diseases, increase plant yield, increase soil nutrient efficiency and space utilization efficiency, and improve soil biological performance. , So they improve soil health.

In Malviya et al. experiment (2021), the results of microbial diversity showed that the intercropping system strengthens soil microbes. The weight of sugarcane plants increased in intercropping with soybeans. Intercropping had a positive effect on organic carbon and nitrogen levels and soil enzymes and microorganisms.

Results of a study by Lee et al. (2020) showed that intercropping system of tobacco and marigold increases microbial diversity and microbial richness.

In one experiment, a intercropping of cucumber with onion or garlic was investigated. Based on the results in intercropping, cucumber yield increased. Urease activity increased in intercropping. Garlic and cucumber intercropping had a greater effect on the fungal community than onion and cucumber intercropping. Studies show that intercropping increases microbial respiration and soil biomass compared to pure cultivation.

2.8. Impact of Forage-Legume Intercropping on Climate Change

Studies have shown that by intercropping of legumes and cereals, climate change due to agricultural activities can be mitigated, because legumes improve the digestion of fiber materials. If the digestion of food in the stomach of ruminants increases, the emission of methane greenhouse gases will decrease. Legumes can prevent soil erosion, nitrogen leaching and carbon loss and increase carbon sequestration.

Biological fixation of nitrogen by symbiotic microorganisms improves soil fertility and reduces the use of nitrogen fertilizer, and reducing nitrogen fertilizer consumption means less use of fossil fuels.

Results of studies by Peichlet al. (2006) show that intercropping systems reduce the concentration of atmospheric carbon dioxide. In the studies of Cong et al. (2015), strip intercropping both increased yield and increased soil carbon and nitrogen.

2.9. Impact of Intercropping on Crop Yield and Farmer Income

In order to meet human food needs and protect the soil, it is necessary to use sustainable agricultural strategies such as conservation agriculture and integrated pest management. Among conservation farming practices, intercropping can increase crop yields and yields, make better use of resources, and benefit smallholders.

2.10. Impact of Intercropping on Soil Erosion

Soil water erosion causes soil losses to be much higher than soil formation. Water and wind erosion is a major cause of soil degradation in the world's arid lands. Due to soil erosion, soil physical properties, nutrients and soil health are affected. Intercropping causes optimal use of resources, sustainable production and reduction of soil erosion. Because in intercropping most of the soil is covered by plants, so soil erosion and leaching are reduced. Manfsky et al. (2015) showed that when corn is grown in a mixture with clover, it requires less nitrogen and less nitrogen leaching. Sharma et al. (2017) found that intercropping of cowpea with maize significantly reduced runoff and soil loss compared to maize monoculture.

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PART-II

LIVESTOCK PRODUCTION

CHAPTER 1

ORGANIC LIVESTOCK SECTOR IN TURKEY WITHIN THE SCOPE OF COMPLIANCE WITH THE EUROPEAN GREEN DEAL: CURRENT SITUATION AND FUTURE

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INTRODUCTION

Since the beginning of the 1990s, the EU has been carrying out important studies on environmental and social sustainability, especially climate change mitigation and adaptation studies. In November 2019, the EU has introduced a new work package called the European Green Deal, which promises to take more precise and ambitious steps on the environment and sustainability (Escarus, 2021).

The agreement had great repercussions in all countries that have economic, political and geographical links with the EU. Because, although it consists of the standards set by the EU for its member states, it has the potential to affect the relations of EU countries with third parties. This situation reveals the necessity of understanding the Agreement well by everyone, considering the wide commercial and diplomatic ties of the EU (Escarus, 2021).

The European Green Deal is a new growth strategy that includes the EU's core objectives of zeroing net greenhouse gas emissions by 2050, the end of economic growth's dependence on resource use (decoupling), and leaving no one and no region behind. In other words, the consensus aims to create jobs and improve the quality of life while reducing emissions (Escarus, 2021).

European Green Deal; It is based on 7 target strategies: clean energy, sustainable industry, construction and renovation, sustainable agriculture from farm to fork, elimination of pollution, sustainable mobility and biodiversity. Sustainable agriculture has a very important place among these strategies and therefore, it is very important to develop and strengthen organic agriculture and climate change mitigation and adaptation studies and practices (Escarus, 2021; Semtrio, 2021).

Organic agriculture/livestock farming is an alternative production system and its positive contribution to climate change mitigation and adaptation studies is much higher than conventional agriculture. For this reason, the European Green Deal envisions member states to convert approximately 25% of their traditional agricultural production levels to the organic system by 2030 (Escarus, 2021; Semtrio, 2021).

In order for Turkey to continue its cooperation with the EU, it needs to develop climate change mitigation and adaptation and organic livestock husbandry activities effectively and rapidly in the agricultural production area, which is expected to undergo the most change and transformation within the scope of the Agreement.

1. EUROPEAN GREEN DEAL AND ORGANIC LIVESTOCK INDUSTRY

1.1. EU Organic Livestock Sector

1.1.1. Number of EU organic animals

In the period 2003-2019, there were increases in the number of all livestock species raised in the organic system in the EU. However, the highest increase was seen in poultry (603.4%), followed by pigs (495.9%), bees (484.2%), cattle (424.5%), sheep (230.6%) and goats (201.9%) followed (Table 1).

Table 1. Change in the Number of Organic Certified Animals in the EU in the 2003-2019*

Species	2003	2006	2009	2012	2015	2019	Change (2003-2019) (%)
Bovine	918 584	1 744 538	2 204 676	3 250 557	3 636 091	4 817 726	+ 424.5
Sheep	1 539 548	2 712 183	3 232 649	4 294 024	4 490 717	5 089 677	+ 230.6
Goat	336 311	517 058	575 266	656 366	758 351	1 015 399	+ 201.9
Pig	252 521	465 538	598 418	912 871	979 354	1 504 824	+ 495.9
Poultry	6 921 331	11 368 575	12 864 077	26 010 830	33 753 615	48 685 483	+ 603.4
Honeybee (Hive)	134 198	535 117*	889 913	1 064 057	776 175	784 024	+ 484.2

*: Anonymous 2021: 2003 year (ec.europa.eu/eurostat., 2014); 2006, 2009, 2012 years (ec.europa.eu/eurostat., 2019); 2015, 2019 years (ec.europa.eu/eurostat., 2021); * 2007 data.

1.1.2. EU organic milk production

In the EU, data showing the production of certified organic milk in some years is insufficient. However, total raw organic milk production in 2015 and 2019 was 4.1 million tons and 5.7 million tons, respectively (Table 2). In the period of 2006 - 2015, the highest increase was observed in cattle milk. In this period, while sheep milk increased, goat milk decreased significantly. Organic sheep and goat milk production is developed level in countries such as Bulgaria, Czech Republic, Slovenia and Ireland. In the EU, organic milk is mainly used in the production of drinking milk and cheese. For example, Greece specializes in the production of organic Feta cheese.

Table 2. Organic Certified Milk Production in the EU in 2003-2019 (tonnes)*

Organic raw milk production	2003	2006	2009	2012	2015	2019
Cattle milk	-	67 061	-	2 013 654	2 666 640	-
Sheep milk	-	87	123	50 410	123 097	-
Goat milk	-	668	911	33 557	59 648	-
Total	20 846	93 818	-	2 736 057	4 142 315	5 715 215

* Anonymous 2021: 2003 year (ec.europa.eu/eurostat., 2014); 2006, 2009, 2012, 2015 years (ec.europa.eu/eurostat., 2019)

1.1.3. EU organic meat production

The total organic meat production of the EU in 2019 is 256 553 tons (Table 3). Beef has the highest share in this production, and poultry meat has the lowest share. Especially after 2006, there were significant increases in organic beef production and decreases in the production of organic meats from other species. It can be said that the countries where organic red and white meat production is concentrated in the EU are Ireland (essentially), Italy, Spain, Denmark and the Netherlands.

Table 3. Organic Certified Meat Production in the EU in 2003-2019 (tonnes)*

Organic Meat Production	2003	2006	2009	2012	2015	2019
Beef	729	8 607	28 736	77 831	139 094	132 791
Sheep meat	378	460	1 370	17 927	27 212	20 238
Goat meat	2	29	135	574	1 203	534
Pork	57	274	18 518	25 516	42 810	55 163
Poultry meat	-	135	6 170	15 066	39 421	47 827
Equine meat	-	0	25	327	800	-
Others	-	1	19	22	1 067	-
Total	1 166	9 506	54 973	137 263	251 607	256 553

* Anonymous 2021:2003 year (ec.europa.eu/eurostat., 2014);2006, 2009, 2012, 2015 years (ec.europa.eu/eurostat., 2019);2019 year; (ec.europa.eu/eurostat.,2021).

1.1.4. EU organic egg and honey production

Organic egg and honey production in the EU has increased significantly after 2003 (Table 4). Organic egg production, which was 534 thousand in 2003, increased to 6.6 billion units in 2019, and organic honey production, which was 2 thousand tons, increased to 7 thousand tons in 2015. It can be said that the countries that are important in terms of organic egg and honey production are Denmark, Norway, Latvia and Italy, Romania and Bulgaria, respectively.

Table 4. Organic Certified Egg and Honey Production in the EU in 2003- 2019 *

Products	2003	2006	2009	2012	2015	2019
Egg (Piece)	534 000	130 000	-	-	3 257 952 526*	6 639 682 378*
Honey (Tons)	2 000	2 058	5 484	6 261	7 201	-

*Anonymous 2021: 2003 year; (ec.europa.eu/eurostat.,2014); 2006, 2009, 2012, 2015 years (ec.europa.eu/eurostat., 2019);2015, 2019 years (ec.europa.eu/eurostat., 2021).

1.2. European Green Deal, Climate Change and Organic Livestock Relations

Climate change due to global warming has accelerated with intensive production and consumption, especially after the industrial revolution, and has become an important problem that closely concerns all countries today (Aydın, 2021).

According to the United Nations Framework Convention on Climate Change (UNFCCC), climate change; It is defined as “changes in climate as a result of human activities that directly or indirectly degrade the composition of the global atmosphere, in addition to natural climate change observed over comparable time periods” (UNFCCC, 1992).

The main factor causing climate change at the global level is the increase in greenhouse gas emissions, and it is estimated that there will be very significant increases in the amount of emissions and, accordingly, in the atmospheric temperature, until 2100.

According to FAO 2017 data, the total greenhouse gas emissions at the global level is 56 Gt.CO2-eq. and the sectors that contribute the most to emissions are respectively; energy (73.2%), agriculture, forestry and land use (18.4%), industry (5.2%) and waste (3.2%) (FAO, 2020; Our World in data, 2020).

Enteric fermentation and animal manures (5.8%) from livestock farms constitute the highest share in the total emissions of the global agriculture sector. This is followed by agricultural land (4.1%), stubble burning (3.5%), cropland (1.4%) and rice farming (1.36%), respectively. (Our World in data, 2020).

Since the beginning of the 1990s, international policies and strategies have been developed to solve the problems created by global climate change (Tablo 5). In particular, the important feature that distinguishes the European Green Deal from other policies is the vision of developing the organic agriculture sector. The basis of this vision is that organic agriculture/livestock regulations and standards have much more positive effects on climate change mitigation and adaptation studies compared to traditional agricultural production systems.

For this reason, it is expected that the development of the objectives especially the protection and improvement of biodiversity (2030 Biodiversity Strategy- COM -2020-380 final) and sustainable agriculture from farm to fork (COM-2020-381 final) of the European Green Deal in the organic system will very positive contribute to the prevention of the negative effects of climate change and ensuring sustainable food security and safety (Green Thought Association, 2020; European Commission Report, 2021).

Sustainable farming strategy from farm to fork; It covers the areas of sustainable food production, processing, distribution and consumption as well as the prevention of food loss and waste.

In this context; By 2030, reduce the use of pesticides by 50%, the use of chemical fertilizers by 20%, the sale of antibiotics for livestock and aquaculture by 50% and allocate 25% of agricultural lands to organic agriculture (currently 7.5%), and equipped with high diversity features at least 10% of them are targeted (Green Thought Association, 2020; European Commission Report, 2021).

Table. 5. International Agreements and Processes against Climate Change

Agreements and Processes	**Country and Date**	**Action Strategies and Goals**
United Nations Framework Convention on Climate Change-UNFCCC	-Brazil- Rio-1992 -It entered into force on March 21, 1994	-First intergovernmental environmental agreement on global warming - Establishment of a new climate regime; reducing greenhouse gas emissions below 1990 levels
Kyoto Protocol	Japan-Kyoto-1997	Signed under the UN Framework Convention on Climate Change; First period: Countries will set carbon emission targets in 2008-2012 and limit temperature rise to 0.02 - 0.28 °C; Second period: Emissions will be reduced by 18% in 2013-2020 compared to 1990.
Paris Climate Agreement	France-Paris-2015	-Entered into force as of November 4, 2016. - By reducing greenhouse gas emissions to 56 billion tons by 2030, keeping global temperature rise below 2°C and preferably 1.5°C by the end of the century. - In order to achieve this goal, especially developed countries should support developing countries financially.

Table. 5. International Agreements and Processes against Climate Change (Continued)

European Green Deal	11 December- 2019- Announced by Ursula von der Leyen, President of the European Commission	Policy areas/strategies - First European 'Climate Law': Target to reduce greenhouse gas emissions by 55% by 2030 and become a carbon neutral continent by 2050: 1- Protect and restore ecosystems and biodiversity for a healthier nature ecosystem; 2- Sustainable Agriculture: Providing healthier, equitable, environmentally friendly and sustainable farming methods from farm to fork and designing the EU food system. Expanding organic farming areas to make EU agriculture socially, economically and environmentally sustainable; 3-Clean energy: Providing clean, cost-effective and reliable energy; 4- Sustainable Industry: Creating more sustainable, cleaner and environmentally friendly production cycles; 5-Construction and Renovation: Reducing activity-related carbon emissions by making the construction sector more sustainable. Build cleaner, environmentally friendly buildings and renovate existing buildings under new policies; 6- Sustainable transport: Accelerating the transition to sustainable and smart mobility. Developing and promoting the use of transport systems/vehicles that are more sustainable, environmentally friendly and cause minimal carbon emissions for both transport and industry; 7- Pollution Prevention: Zero pollution target for a toxic-free environment. Ending environmental pollution (air, water, soil) quickly and effectively.
6th Report of the Intergovernmental Panel on Climate Change (IPCC 2021)	Released in 2021	Consequences and observed changes of climate change scenarios
26th United Nations Conference of the Parties on Climate Change (Conference of the Parties-COP)	Scotland-Glasgow-31 Oct-12 Nov/2021	- UNFCCC is held annually (197 countries) -The reduction and adaptation targets and action plans of the countries are discussed -An important milestone before the global inventory in 2023.

2. THE STATUS AND FUTURE OF THE TURKISH ORGANIC LIVESTOCK SECTOR IN ACCORDANCE WITH THE EUROPEAN GREEN ACCOUNT

2.1. Turkey Organic Livestock Industry

2.1.1. Number of organic animals

Although organic livestock initiatives in Turkey started mainly after 2006, they have not developed sufficiently until today. According to the data of 2020, mainly organic cattle, sheep and goats, chickens and honey bee (hive) are produced and their shares in the total number of animals of the same species are 0.04%, 0.004%, 0.29% and 0.86%, respectively (TOB, 2021).

In 2006-2020, there were significant increases in the number of organic chickens (40 323%), cattle (517%) and bees (165%), and significant decreases (79.7%) in the number of sheep and goats, in order of height (Table 6). The increase in the number of organic chickens is due to the fact that the traditional poultry sector is very developed and the market prices of organic eggs are cheaper than other organic food products. Among the effective factors on the rapid development of the number of organic beehives, the Ministry of Agriculture and Forestry (TOB) only supports this sector, the consumer perception and demand for organic bee products increase, the transition from the traditional system to the organic system is easier, etc. factors can be shown.

Table 6. Change in the Number of Organic Certified Animals by Species in 2006-2020 in Turkey (TOB, 2021)

Farm Animal Species	2006	2020	2006-2020 Change (%)
Cattle (Head)	1 238	7 643	+ 517.4
Sheep (Head)	10 399	2 204*	- 79.7 *
Goat (Head)	474		
Chicken (Number)	2 700	1 091 423	+ 40 323.1
Beehives (Number)	26 596	70 385	+ 164.6

*Since the numbers of sheep and goats were not given separately in 2020, the calculation was made on the total number of animals.

2.1.2. Organic milk and red meat production

Turkey's organic certified cattle and small ruminant milk and meat production in 2020 is 21 thousand tons; 609 tons and 701 tons; 5 tons, respectively (Table 7). Organic cattle milk is produced at the highest levels in the Aegean, Central Anatolia, Marmara and Black Sea regions, respectively. Organic small ruminant milk is produced only in Marmara region. Organic beef is produced only in the Marmara region, while organic ovine meat is produced in the Black Sea and Marmara regions.

Table 7. Organic Milk and Red Meat Production by Regions in Turkey in 2020 (TOB, 2021)

Regions	Cattle			Small Ruminant		
	Number (Head)	Milk (Tons	Meat (Tons)	Number (Head)	Milk (Tons)	Meat (Tons)
Marmara	2 921	2 089	701.1	2 109	608.8	1
Aegean	2 806	11 147	0	0	0	0
Mediterrenian	0	0	0	0	0	0
Central Anatolia	1 165	6 039	0	0	0	0
Black Sea	751	1 917	0	95	0	4.1
Eastern Anatolia	0	0	0	0	0	0
Southeastern Anatolia	0	0	0	0	0	0
Total	7 643	21 192	701.1	2 204	608.8	5.1

2.1.3. Organic chicken eggs and meat and honey production

Turkey's production of certified organic chicken eggs and meat and honey in 2020 is 183 million units, 50 tons and 1000 tons, respectively (Table 8). The regions where organic chicken egg and meat production is developed are Aegean, Marmara, Black Sea, Eastern Anatolia and Mediterranean and Aegean, Marmara, Black Sea, in order of height. The regions where organic honey production is at the highest levels are respectively; Eastern Anatolia, Black Sea, Mediterranean, Southeastern Anatolia, Central Anatolia, Aegean and Marmara.

Table 8. Organic Chicken Egg and Meat and Honey Production by Regions in Turkey in 2020 (TOB, 2021).

Regions	Poultry Farming			Beekeeping	
	Number	Egg (Number)	Meat (tons)	Hive (Number)	Honey (tons)
Marmara	335 436	49 419 544	16.8	1 421	14.8
Aegean	287 512	63 856 057	31.9	2 124	41.5
Mediterrenian	15 615	2 864 400	0	6 935	143.1
Central Anatolia	0	0	0	3 016	44.7
Black Sea	332 517	48 042 026	1.1	23 511	351.1
Eastern Anatolia	120 343	18 809 900	0	28 698	357.0
Southeastern Anatolia	0	0	0	4 680	76.4
Total	1 091 423	182 991 927	49.8	70 385	1 028.4

Organic animal production is carried out in almost every region in Turkey. However, its development progresses very slowly due to factors such as the fact that other production branches other than beekeeping are not supported by Ministry of Agriculture and Forestry, organic animal products are expensive, and the difficulties in transitioning to the organic system due to the structural, technical and economic problems of traditional systems. There are differences between regions in terms of the type and density of organic animal husbandry. It can be said that it is mainly caused by environmental, economic and socio-cultural factors specific to the regions. However, the level of data and knowledge showing the effects of these factors on organic animal production at the regional level is not sufficient. But it can be accepted that especially the climate, geographical conditions, the condition of vegetation (pasture and other forage resources) and of water resources and the distances of regions/provinces to major markets have a very significant effect. For example, the fact that most of the companies marketing organic products are located in the western regions, especially in the Aegean, limits the spread of organic production in the inner, northern and eastern regions.

2.2. The Situation and Future of the Turkish Organic Livestock Sector in Terms of Compliance with the European Green Deal

Turkey's total emission amount in 2019 is 506.1 million tons of CO_2 equivalent. This includes, in order of height, energy (364.4 million tons; 72.0%), agriculture (68.0 million tons; 13.4%), industrial processes and product use (56.4 million tons; 11.2%) and waste (17.2 million tons; 3.4%) constitute the sector. The total emissions of the agricultural sector are, in order of height, enteric fermentation (33 million tons; 49%), agricultural soils (24 million tons; 36%), manure/fertilizer management (8.6 million tons; 13%), urea applications (13 million tons, 1.9%), rice production (268 thousand tons; 0.4%) and stubble burning (165 thousand tons; 0.2%) (TÜİK, 2021).

As can be seen from Table 9, organic animal production and climate change mitigation and adaptation studies in Turkey are carried out by the state, the private sector, non-governmental organizations (NGOs), control and certification institutions (CCI) and universities.

Turkey became a party to the UNFCCC on 24 May 2004, the Kyoto Protocol on 26 August 2009, the Paris Agreement in October 2021 and the Glasgow Conference of the Parties in 2020. "Green Agreement Action Plan" and "Presidential Circular No. 2021/15" was published in the Official Gazette on 16.07.202. The Green Reconciliation Action Plan prepared by the Ministry of Commerce has also been published.

Climate change mitigation and adaptation studies in agriculture/animal production are mainly carried out by TOB. According to the results of the studies carried out in the livestock sector to date; Improvement of enteric fermentation, manure management and pasture quality are recommended as reduction action plans, and mainly an effective water and energy management is recommended as adaptation action plans.

Since the organic livestock sector in Turkey is not developed enough, it can be said that studies on the analysis of the effects of this sector on climate change mitigation and adaptation targets and studies are also at very low levels. However, climate change mitigation and adaptation studies and practices are at promising levels in the dairy and poultry sectors that produce in the traditional system. For example, according to Ministry of Agriculture and Forestry 2020 data; in the poultry industry; There are 1513 Broiler Chickens, 64 Layer Chickens and 162

Turkey Farms certified by Good Farming Practice. If organic livestock is supported, an increase in the transition to the organic system can be expected in the whole livestock sector, especially in the poultry sector. However, considering both the objectives of the European Green Deal and Turkey's being a party to the Paris Agreement, it is necessary to accelerate the efforts to develop the organic livestock sector. It can be suggested that these studies mainly focus on the following areas:

1) Planning the regions where organic animal production will be carried out in Turkey, taking into account factors such as animal species and breed, climate and geographical conditions, feed and water resources, and marketing infrastructure.
2) Economic support of the sector that makes or will do organic livestock farming
3) Conducting broadcasting activities to raise awareness of consumers about the positive effects of organic livestock farming on the environment, animal and human health.
4) Working towards establishing Organic Agriculture Standards compatible with Turkey's own country conditions
5) Accelerating the work of analyzing the relations between organic animal production and climate change and determining action targets and plans according to the results obtained, in cooperation with all stakeholders.

Table 9. Summary of Organic Animal Production and Climate Change Mitigation and Adaptation Studies in Turkey

Institutions	**Organic livestock studies**	**Climate change mitigation and adaptation studies (traditional production)**
Government	-MAF -GAP and OAD: Management and Control -MAF- GDAR: Research (especially there is rapid development in crop production)	TURKSTAT: It started greenhouse gas emission estimation studies in 2006 and presented its 15th report in 2021.
		MAF: Turkey's strategy and action plan for combating agricultural drought (2013-2017); Strategic Plans (2019-2023); National Basin Management Strategy (2014-2023) etc. MAF- GDAR: Animal husbandry research is at a low level
		MEUCC: Turkey Climate Change Notifications; Turkey Climate Change Action Plan (2011-2023); Turkey Climate Change Strategy (2010-202/2023); Turkey Climate Change Adaptation Strategy and Action Plan (2011-023); Numerous projects: Low Carbon Turkey etc.
Private Sector (including CCI's)	Very poor at the level of research and development	Dairy industry - Yaşar Holding, since 2007 - SÜTAŞ, since 2010 - ASÜD, since 2020 (work on implementation is in progress) Poultry industry - Ak Chicken, Alpine Turkey, Avigen Anadolu, Pak Chicken, Anako, Banvit, Beypiliç, CP (work on implementation is in progress)
Civil Society Institutions	Numerous: Organic Agriculture Associations, Organic Agriculture Associations Federation, etc.	Numerous: Nature Conservation Menter, Good Thought Society, etc.
Universities	Insufficient	There is a rapid increase

MAF: Ministry of Agriculture and Forestry; GAP: Good agricultural practices; OAD: Organic Agriculture Department; GDAR: General Directorate of Agricultural Research; MEUCC: Ministry of environment, urbanism and climate change.

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CHAPTER 2

GENERAL PRINCIPLES AND MANAGEMENT STANDARTS OF ORGANIC (ECOLOGIC, BIOLOGIC) LIVESTOCK PRODUCTION
(Cattle, Sheep, Goat and Poultry)

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INTRODUCTION

Global population growth and the increase in the demand of agricultural products resulted in adoption of intensive production (also known as conventional production) in livestock production, like in plant production. Since the main priority of intensive production is to yield high amount of and economic product per unit area, ecologic balance and health criteria in product quality are of secondary importance in this process (Aksoy & Altındişli, 1998). As a result of this, like in conventional plant production, the harmful effects of conventional livestock production on the environment, animals and humans began to be visible.

In conventional livestock enterprises, due to high stocking density in animal houses inadequate workforce and improper maintenance causes the animals to be more susceptible to diseases. In addition, the diseases such as *Nail and Foot Diseases and Mastitis* were observed to increase. This situation leads to higher amount of chemical medicine use and poses the risk of higher of residues in animal products. The feed and some additives used in conventional livestock production cause more important problems (Anonymous, 1999; EFSA, 2019). Conventional plant production, triggers soil erosion, upsets ecological balance by genetically modified seeds, intensively used synthetic chemical fertilizers and pesticides and thus threatens both animal and human health. In addition, the use of various unhygienic slaughterhouse by-products and cadaver powders which may contain drug residues as an economic feed source leads to some health problems. For example, *Bovine Spongiform Encephalopathy* (*BSE) /also known as Mad Cow Disease* in colloquial language, which starts with neurologic symptoms and results in mortality in a few weeks, is an important contagious neurologic disease caused by the use of this kind of feed in conventional livestock production (Kantarcı, 2000). It was suggested that this disease emerged in early 1980s in England due to the addition of cadavers of sheep which died of scrapie (a degenerative neurologic disease) into cattle feed for lowering the costs of some feed producers; and that the prevalence of the disease decreased when this application was prohibited in 1988 (Küçükersan & Gültekin, 2001). However, it was also reported that during this period or in the following years, a fatal degenerative neurologic disease *Creutzfeldt Jacop (CJ)* disease emerged in humans who consumed the meat of infected cattle and the meat of cattle which consumed cadaver powder of the infected cattle as feed. In conventional livestock production, in addition to feeds, the use of various feed additives may cause some important health problems. For example, the use of antibiotics in poultry animals, particularly in broilers for preventive, digestive purposes which stimulate feed efficiency and thus animal growth was found to be highly unfavourable. While the most important principle for the use of antibiotics was that they were different from the ones used for treatment (curative) purposes in humans and animals and they had no connection or interaction with those, it was found that this principle was not obeyed on occasional basis. World Health Organization (WHO) report stated that due to misuse of antibiotics in broilers, various microbes gained immunity and that in case this unconscious antibiotic use continues*, the antibiotics will loose effect against strep throat and otitis in humans*. For these reasons, the use of antibiotics for preventive and digestive purposes except for the treatment of the diseases is prohibited in European Union states and Turkey (Tuncer, 2007). The use of anabolitics, which include hormones and similar substances, for stimulation the growth may have negative effects on human health. Among synthetic anabolitics, stilbenes which are used in cattle feed are known to be prohibited all over the world as it was found to have *carcinogenic and gene structure damaging effects (*Erkek & Kırkpınar, 1993). In recent years, in addition to the reactions to the problems related with conventional livestock production and environment protection awareness, animal welfare increasingly gained importance at social level due to the interest in animals' rights. (Animal well-being is the condition in which animals experience good health, are able to express a diversity of species-typical behaviors. Protecting an animal's welfare means providing for its physical needs where the animal is provided with adequate nutrition possibilities and can be protected from extreme weather conditions, stress, injury and diseases). As a result of these, for the prevention of health problems that may arise due to conventional livestock production and for paying attention to environmental protection and animal welfare, organic livestock production is recommended. Organic (ecologic, biologic) livestock production involves a production system that includes health criteria in product quality besides product volume. Therefore, the purpose of organic livestock production is to produce organic products restricted or free from disease-agent microorganisms harming human health and various synthetic chemical residues having long-term harmful effects (Anonymous, 2010). In addition, organic livestock production takes environmental protection and animal welfare into account.

1. THE ESTABLISHMENT OF ORGANIC LIVESTOCK ENTERPRISES

Organic livestock production is carried out under the supervision of an enterprise that is authorized from the decision-making of starting the production of organic products to the yield of organic products. In organic livestock production enterprises, all animals have to be organic. In organic livestock production enterprises, the animals should be given identification cards, in production process; regular records should be kept on entrance and exit of the animals. In organic livestock production enterprises, firstly animal selection should be paid attention. Then, the animals should be provided with organic production and nutrition principles.

1.1. Selecting Animals for Organic Livestock Enterprises

The breeds or strains that can adapt to local conditions and are resistant to climate conditions and diseases should be selected. For that reason, local breed and the hybrid of their races should be considered first. The foreign breed that adapted to the local region can also be used, but the use of genetically modified animals is prohibited. Under the supervision of the authorized organization, the existing animals in conventional livestock production enterprises can be included in a conversion process and an organic flock can be formed. For forming an organic flock in a newly established enterprise, the animals can be transferred from other organic enterprises or from conventional enterprises on condition that the animal is under a certain age limit (Table 1).

Table 1. The Age of Conventional Animals to be Brought from Conventional Livestock Enterprises to Organic Livestock Enterprises

LARGE AND SMALL RUMINANTS (Cattle, sheep and goat)	
- Calves	maximum 6 months old
- Lambs and kids	maximum 2 months old
POULTRY (Chicken)	
- Broiler and laying chicks	maximum 3 days old

Source: European Union Commission Regulation EC No:889 (2008)
* When a new herd or flock is formed for the first time, if organic animals are not adequate in number, non-organic animals from conventional livestock enterprises whose age are in compliance with the regulations can be brought to organic livestock enterprises.

The calves, lambs and kids to be brought from conventional livestock enterprises should be transferred to the organic livestock enterprise after they consume colostrum for strengthening their immune system and preferably after they consume mother's milk or milk replacer feed until they get familiar with the feed. The chicks should be brought to organic livestock enterprises after they hatch and before they consume 3-day nutrition material reserve in their bodies, namely prior to starting conventional feed in their enterprises.

For increasing a herd or flock in organic breeding enterprises, some exceptions are made about the age of non-organic animals to brought from conventional enterprises. For example, maximum 10% adult large ruminants and 20% adult small ruminants may join the flock as an unborn female (except the animal breed on the farm is in danger of extinction) after undergoing health control and inclusion into conversion period. These percentages may be increased by up to 40%, subject to prior authorization by the authorized authority, when a major extension to the herd is undertaken, when a breed is changed, when a new livestock specialization is initiated and when the breed faces extinction risk. When required, conventional breeding adult male animals may also join the organic herd. However, the extension of the herd should not cause environmental pollution. In other words, the increased amount of manure depending on the increase in number of animals should not cause nitrate pollution in agricultural area of the enterprise. Therefore, the total stocking density should not exceed the limit of 170 kg of nitrogen per year/hectare of agricultural area (the limit of 170 kg of N/ha/year is equivalent to 2 large animal units). When this amount is exceeded, namely when the number of animals is increased, the entrepreneur should make use of the manure he/she stocked in another enterprise. Otherwise, the authorized organization can reduce the number of animals to prevent nitrate pollution.

1.2. Conversion Period

Conversion process is the transition from non-organic to organic animal production. In other words, it means a period of time from the initiation of organic animal production to the approval of the product as a certificated organic product. Conversion period varies according to animal species and yield (Table 2).

Table 2. The Conversion Periods according to Animal Species and Products

LARGE AND SMALL RUMINANTS (Cattle, sheep and goat)	
- Cattle meat production (minimum ¾ of the animal's life time at any case)	12 months
- Sheep and goat meat production	6 months
- Cattle, sheep and goat milk production	6 months
POULTRY (Chicken)	
- Broiler meat production	2.5 months (10 weeks)
- Egg production	1.5 months (6 weeks)

Source: European Union Commission Regulation EC No:889 (2008)

Conversion period in open-air grazing area or open-air exercise area or pasture is two years. The conversion period in these areas for non-herbivorous animals is 1 year, however if the mentioned areas were not treated with other products apart from those allowed in the attachment of the related regulation, the conversion period may be reduced to 6 months by the authorized organization.

2. ORGANIC ANIMAL HUSBANDRY

Organic livestock shall be born and raised on organic holdings. Natural methods for reproduction are preferred in organic animal husbandry. Artificial insemination is however permitted. Artificial insemination should be done with the sperm which is collected and stored with natural methods from the breeds. Other forms of artificial reproduction, such as cloning and embryo transfer, are not allowed. The use of hormones or other substances are not allowed for reproduction control. These kinds of substances can be used on a diseased animal only for therapeutic purposes upon veterinary recommendation. Organic animal husbandry should ensure comfortable housing conditions and careful maintenance practices, which take animal ethics into account for animal welfare (Gray, 2001).

2.1 Housing Conditions

The livestock housing should be provided with sufficient clean air and daylight, should be built to protect the animals from extreme weather conditions using building materials and equipment that are not harmful to the animals and humans. The housing conditions in organic livestock production enterprises differ from conventional animal husbandry in terms of form and size that allow for the natural behavior of animals. These differences are useful for animal welfare and for the prevention of susceptibility to diseases by strengthening the immune system of the animals. For this reason, the housing for organic livestock production should offer both suitable stocking densities for indoor areas and permanent access to safe and when required shady open-air areas, in other words an outdoor area (Table 3).

For instance, laying hens cannot be kept in cages. In addition to the indoor area, these animals should have permanent access to outdoors covered with plants for meeting their exercise needs. And the buildings should have easy access from indoor to outdoor areas, they should have exit/entry pop-holes of a size adequate for the birds, and these pop-holes should be minimum 4 m long per 100 m^2 in the poultry house. (in addition, the total usable area of poultry houses for meat production on any single production unit, must not exceed 1600 m^2) In livestock housings, the ground should be smooth but not slippery. In poultry houses, minimum 1/3 of the ground should be smooth, not patched or meshed. In laying hen houses, minimum 1/2 of the ground should be convenient for collecting the manure.

As bedding, hay or other suitable materials should be used. In organic agriculture, base can be improved using the mineral substances used as manure. Possible manure-related environmental pollution in animal housings should be prevented by collecting the wastes in manure holes by a suitable management. Animal housings should have adequate manger and waterer, the animals should have easy access to feed and water. In laying hen houses, adequate number of laying nest and perch in proportion with the size of the animal should be made available (18 cm perch for each laying hen and one laying nest for every 8-laying hen and 120 cm^2 laying nest floor area per hen in every laying nest)

Table 3. Recommended Animal Housing Areas for Animal Categories

LARGE AND SMALL RUMINANTS (Cattle, Sheep and Goat)	Livestock housing Indoors area	Livestock housing Outdoors area
Cattle		
Fattening cattle up to 100 kg of live weight	1.50 m^2	1.10 m^2
" 200 kg "	2.50 m^2	1.90 m^2
" 350 kg "	4.00 m^2	3.00 m^2
" over 350 kg "	5.00 m^2	3.70 m^2
* for every 100 kg over 350 kg, additional 1.00 m^2 indoors area, 0.75 m^2 outdoors area		
Dairy cows m^2/head	6.00 m^2	4.50 m^2
Bulls for breeding m^2/head	10.00 m^2	30.00 m^2
Sheep and Goat		
Adult sheep and goats m^2/head	1.50 m^2	2.50 m^2
Lambs and kids m^2/head	0.35 m^2	0.50 m^2
POULTRY (Chicken)	Poultry House Indoors area	Poultry House Outdoors area
Broiler		
- (In fixed housing)	10 broiler/1.00 m^2 (or 1.00 m^2 for 21 kg live weight)	4.00 m^2/Broiler
- (In mobile housing)	16 broiler/1.00 m^2 (or 1.00 m^2 for 30 kg live weight)	2.50 m^2/Broiler
Laying hens	6 laying hen/1.00 m^2	4.00 m^2/Laying hen

Source: European Union Commission Regulation EC No:889 (2008)

2.2. Maintenance

After ensuring the comfortable housing conditions, the important point is to provide careful husbandry practices taking animal ethics into account (Schmid, 2010). To ensure animal health, the vaccinations, disinfections and every kind of hygienic conditions based on the veterinary recommendations are allowed. If, despite all of the above preventive measures, a disease breaks out, alternative treatment techniques and preparate which do not leave residues in animal products should be used (e.g., plant extracts, probiotics, homeopathy, biodynamic techniques and acupuncture). In emergencies, if synthetic medication is required, these medications should be used considering toxicology list. To deem a product organic, a certain period of time should elapse starting from the latest drug dose. The withdrawal period is to be twice the legal withdrawal period of conventional, in a case in which this period is not specified, it is 48 hours. With the exception of vaccinations, treatments for parasites and compulsory eradication schemes, if synthetic medications are used for more than three times in a year (or more than one course of treatment if their productive lifecycle is less than one year) the livestock concerned, or produce derived from them, may not be sold as organic products, and the livestock can undergo the conversion periods. Records of documented evidence of the occurrence of such circumstances shall be kept for authorized bodies. In addition to hygienic precautions in animal houses, actions putting the animals under stress and thus weakening their immune systems should be avoided. This situation is required also in terms of animal ethics. Operations such as tail docking, or beak-cutting in hens should not be carried out routinely in organic farming. However, physical interventions such as castration, dehorning and ear-tagging can only be applied with the permission of the authorized organization for reasons of safety or if they are intended to improve the health. Where livestock are reared in groups, the size of the group must depend upon their development periods and the behavioral needs of the species concerned and must be determined by the inspection authority. The stocking density in animal houses should not prevent the natural behaviors of the animals (Lampkin, 1990). Poultry house should not contain more than 4800 broilers and 3000 laying hens (2500 turkeys or geese). Tethering of cattle is prohibited in organic animal husbandry. However, on condition that the enterprise proves that tethering is required for the safety and welfare of the animals, the authorized organization may allow the animals to be tethered. If it is not possible to keep animal groups consisting ten or less number of animals appropriately to their behavior requirements, provided that they have access to open-air areas at least twice a week, the animals can be tethered with the permission of the authorized organization. Housing for livestock shall not be mandatory in areas with appropriate climatic conditions where the animals can live outdoors. However, it is compulsory that livestock shall have permanent access to regular open-air areas and/or open-air exercise areas and/or pastureland. The livestock should be able to use one of these areas where appropriate.

In cases where ruminants such as cattle, goat and sheep have access to pasturage during the grazing period and where the winter-housing system allows the animals to move freely, it is not compulsory to take these animals outdoors, in other words, in open-air. However, the bulls older than one year old must have access to open areas. On the other hand, as for the final fattening phase of the ruminants for meat production, these animals can be kept indoors for a certain period to be determined by the authorized organization, on condition that this period does not exceed 1/5 of the lifetime of the animals. In organic livestock production, the calves should not be kept in individual sections after one week of age (Grundin, 2019). Poultry should have access to an open-air area, mostly covered with vegetation for at least one third of their life. (water fowl should have access to a stream, pond or lake whenever the weather conditions permit in order to respect animal welfare requirements and hygienic conditions) Buildings should be emptied of livestock between each rearing. The buildings and fittings should be cleaned and disinfected during this time. In addition, the exercise areas should be abandoned to allow vegetation to grow back. Authorized organizations establish the period for which the poultry houses should be emptied. For laying hens, the duration of natural light and artificial lighting cannot exceed maximum 16 hours per day. The continuous nocturnal rest period without artificial light is minimum eight hours. Transport and slaughter of livestock must be carried out so as not to stress the animals. This application is necessary for animal's ethics. Transport of the animals should be carried out in such a way to cause minimum stress on the animals, in the shortest period of time and without using allopathic tranquillizers. Organic animals, if possible, must be slaughtered in different slaughterhouses from the conventional animals, if not, the organic animals must be slaughtered in the same slaughterhouse but at different times. The animals should be slaughtered in such a way not to stress the animal, using appropriate slaughtering methods by qualified personnel. To avoid the use of intensive breeding methods, birds are either fed until they reach a minimum age or slow growing bird genotypes are selected. Where slow growing bird genotypes are not used by the operator, slaughter shall take place at the 81 days minimum age for broilers.

3. FEEDING OF ORGANIC ANIMALS

3.1. The Quality, Quantity of Water and Watering Method

The drinking water of animals must have the same quality with human’s drinking water in terms of hygiene, especially the nitrate content of the water should be paid attention. The animal should have easy access to adequate amount of drinking water.

3.2. The Quality, Quantity of Feed and Feeding Method

Feed quality has a direct effect on animal’s health. Therefore, the new-born ruminants first should be fed on colostrum for strengthening their immune system until their rumens develop. In other words, the new-born ruminants should be fed on their mother’s milk or if not possible, with the same herd’s milk until the intake of sufficient roughages. For this reason, high quality organic forage and concentrate should be made available to young ruminants from the second week of age for adjusting them to consume feeds. Milk consumption period is minimum 90 days for the calves and minimum 45 days for lambs and kids. After weaning, young ruminants should be fed by organic roughages and concentrates to meet their nutritional needs. The roughages and concentrates in organic livestock production should be organically produced and especially of plant origin. The producers should supply these feeds from their own or nearby enterprises as far as possible. Organic plant origin feeds are the ones that are not produced by GMO's (genetically modified microorganism) whose production process is based on restricted or zero use of synthetic chemical fertilizer, pesticide, insecticide and growth promoters (such as hormone). Thus, this feed is not harmful for the animals, and thus for the humans. In addition to mechanic fullness in ruminants, for preparing balanced rations of crude fiber and roughages used as energy-source, protein-rich types should be preferred. For this purpose, legumes and a mixture of legumes with gramine should be used to obtain hay and silage. In preparation of organic silage only the permitted additives helping fermentation should be used. It is important for organic enterprises to have organic pasture and grassland for economic roughage supply. The total stocking density should not cause harm due to over-grazing and manure. In other words, stocking density should not exceed the limit of number of animals producing 170 kg of nitrogen per hectare in a year or the limit of approximately two large animal units. It is important for organic livestock production enterprises to have organic pastures and grasslands as fresh and clean weather and daylight strengthens the immune systems of the animals. The animals should be able to use the pasture and grassland to the extent the climatic conditions permit. Organic livestock can use the same pasturage with the conventional animals but at different times based on certain conditions. These conditions include completion of conversion process of the land, extensive production origin of the conventional livestock and getting the approval of the authorized organization. In addition, organic and conventional livestock should not graze at the same time. Among feed concentrates, organic grains can be used as energy source. The oilseed to be used as protein source should not be treated with chemical solvents during production or processing. As organic animal-origin feeds, milk and dairy products, marine animals, their products and by-products can be used. The use of slaughterhouse by-products and cadaver powder is prohibited. Feed from sustainable fisheries has the following conditions: Feeds are produced or prepared without the use of chemical solvents; the use of baits is restricted to non-herbivorous animals. The use of hydrolysed fish proteins is limited to young animals.

In organic feeding, the rations can contain various macro and micro elements and natural vitamins in addition to salt. Synthetic vitamins identical to natural vitamins can be used for monogastric animals, however in ruminants, only vitamin A, D and E are allowed to be used with the permission of the authorized organization.

If feed is to be prepared in feed factories (processed feed), the authorized organization will first issue an aptitude certificate stating that at least 95% of the product's dry matter is organic. Processed feeds can contain a permitted amount of conventional or conversion period feeds. For this reason, dry matter percentages of organic and/or conversion period and/or conventional, and total percentage of animal feed of agricultural origin feed quantities have to be specified on organic feed labels. Organic processed feeds cannot be prepared with the equipment used in conventional feeds. If organic feeds are going to be prepared in conventional feed equipment, the equipment first have to be cleaned using the permitted substances. The name of the authorized organization should also be specified on the label.

Even if organic, since the roughages and concentrates to be given to the animals affect animals' health, roughages are recommended to be preferred in significant quantities. For example, approximately 60% in ration dry matter (in nutrition of high yield dairy cows, this can be reduced to 50% in a 3-month period, starting from lactation). This kind of feeding is convenient for the digestion physiology of the ruminants. These animals can significantly benefit from the feeds having high cellulose content. Roughage-based nutrition is important as it prevents acidosis disease which is quite common in conventional ruminant feeding due to fast and high amount of grain consumption. Roughages, fresh or dried fodder and silage can also be used in nutrition of poultry. In addition, relevant authorities permit using the feeds in conversion periods up to 30% and using the feeds in conversion period and from the same enterprise up to 60%. The method of feeding the animals also has an effect on animals' health. Short feeding durations and there are not sufficient numbers of drinking and feeding troughs, result in fighting among the animals as the stronger ones want to eat first and cause unnecessary stress and injuries. Therefore, like in poultry, large and small ruminants should be offered an environment where it is possible to consume feed whenever they want.

3.3. Feed Additives

In addition to the quality, quantity of feed and water and the method of feeding or watering the animals, the additives significantly affect animals' life. In organic animal feeding, microorganisms (probiotics), enzymes and organic acids are allowed to be used as additives. However, apart from the treatment of the diseases, it is prohibited to use antibiotics for preventive, digestive purposes or for stimulating hormonal growth. The use of antibiotics causes significant health problems in conventional livestock production. Besides, the use of genetically modified organisms as feed additives is prohibited (Kilcher, 2011).

4. CONCLUSION AND SUGGESTIONS

Organic (ecologic, biologic) livestock production is a production system which considers health criteria, environmental protection and animal welfare in product quality in addition to product quantity. In organic production, organic raising and nutrition should be offered to animals. Organic livestock production should be based on the provision of good animal housing and careful maintenance conditions.

On the other hand, organic livestock feeding should be based on careful planning of water and feed quality, quantity and the method of feeding and watering the animal, and the use of permitted feed additives. The fact that there is a huge demand for organic plant-origin feeds in organic livestock production indicates that especially organic large and small ruminant production enterprises should have organic plant production. Therefore, creating an animal-plant production cycle in organic livestock production enterprises, a close system should be targeted. This kind of a system will provide healthy animal products. In addition, alternating plant production unit with feed plants, supply of manure will improve the structure and content of the soil and will reduce the cost of the animal and plant-origin products to be supplied from the enterprise.

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CHAPTER 3

ORGANIC DAIRY CATTLE FARMING

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INTRODUCTION

Organic agriculture has developed as a response to the problems created by industrial agriculture on the environment, animal and human health (Röss et al., 2018). In order to eliminate the devastating consequences of the Second World War as soon as possible, very important technological developments were made in the agricultural sector, as in all areas (Ak, 2004; Bayram et al., 2007). There was an increase of up to 100% in agricultural products, especially with the use of new agricultural techniques and technologies, which were initiated in the 1960s and called the "green revolution". However, this production system, which does not prioritize human and animal health, ecological balance and product quality, has reached a point where it cannot be sustained anymore because it causes rapid deterioration of the ecosystem (Ak, 2004; Bayram et al., 2007).

According to actual data, organic agriculture is practiced in 187 countries and 72.3 million hectares of land, the market value is reported to be 106.6 billion Euros (Willer et al., 2021). Consumers stated that their reasons for preferring organic products were health and nutritional concerns, desire to protect the environment and animal welfare, and the distrust of products derived from the industrial production method (Hoffmann & Wivstad, 2015; Smigic et al., 2017). Following fruit and vegetables, organic milk and milk products are the most demanded (Palupi et al., 2012). Since organic milk is produced without the use of chemical fertilizers, hormones, various other synthetic chemicals and genetically modified feeds, it is a sensitive production model in terms of animal and human health as well as the environment (Schwendel et al., 2014).

In organic cattle farming feeding is pasture-based, breeding practices used ensure animal health and welfare, the use of concentrates is limited in the ration and the use of antibiotics and hormones is prohibited, hence it differs from conventional cattle farming (Schwendel et al., 2014; Bayram, 2019; Rodriguez-Bermüdez et al., 2019).

Organic livestock farming can be described as an environmentally friendly farming technique that does not use any additives and aims to offer healthier products to consumers by allowing farm animals to display all their natural behaviors, ensuring completely organic feeds without the use of feed additives that threaten human health such as hormones, antibiotics, etc. (Ak & Karaman, 2008; Bayram et al., 2013).

1. THE STATUS OF ORGANIC DAIRY CATTLE FARMING IN EUROPE AND TURKEY

1.1. Organic Dairy Cattle Farming in Europe

Milk and milk products are the most demanded organic animal products (Palupi et al., 2012). In order to meet the increasing demand, supports and incentives are provided to farmers in most of the developed countries, especially in the Unites States of America (USA) and member states of the European Union (EU), through these supports there are significant increases in the number and the sizes of dairy cattle enterprises as well as organic milk production. Organic milk production data of some EU member countries in 2020 are presented in Table 1 (Anonymous, 2021a).

Table 1. Organic Milk Production of Some EU Member Countries

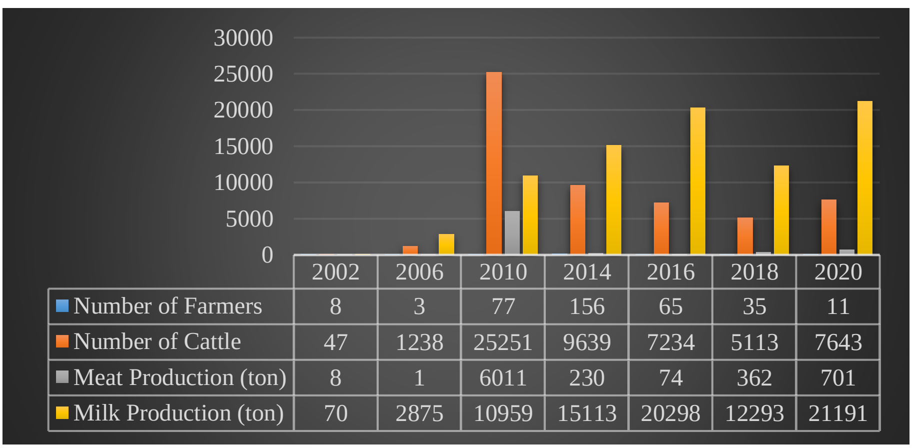
Countries	Organic Milk Production (ton/year)	Conventional Milk Production (ton/year)	Proportion of Organic Milk Production (%)
Germany	1 184 742	31 762 520	3.73
France	1 075 631	25 545 330	4.21
Denmark	708 400	5 615 500	12.62
Austria	642 340	3 165 870	20.29
United Kingdom	573 500	15 429 000	3.72
Sweden	464 170	2 704 390	17.16

Among the EU member states, Germany has the leading position in terms of organic milk production and it is followed by France and Denmark. The percentages of organic milk produced annually of the total milk production of these three countries are 3.73%, 4.21%, and 12.62%, respectively. The key factor enabling the development of the organic milk production sector in these countries are the premiums paid to organic milk-producing enterprises. Incentive support for organic milk is 50% in France, 25% in Denmark and 9% in Austria.

1.2. Organic Dairy Cattle Farming in Turkey

Turkey has a significant potential for organic cattle farming with its location, geographical conditions, uncontaminated soil resources, plant and animal product diversity, indigenous animal being well adapted to the conditions of the country, the abundance of natural meadows and pasture areas, and large lands suitable for forage crops cultivation (Kaymakçı et al., 2004; Bayram et al., 2007). The yield per animal and the income level of the breeders are quite low in the country, since the use of quality feed that are required for profitable animal husbandry is considerably low. Sheep and goat breeding predominantly depended on pasture, and in most regions, 80%-90% of the feed requirements of the animals are met from areas such as meadows, pastures and plateaus. Breeding is mainly carried out with low yielding but disease-resistant indigenous breeds. Especially in the Eastern Anatolian Region, where intensive agricultural activities are not carried out and where there are no industrial facilities, there is significant potential in terms of organic livestock farming (Ak & Kantar, 2007; Bayram et al., 2015).

Changes in organic cattle breeding in Turkey in the last 20 years are summarized in Figure 1.



	2002	2006	2010	2014	2016	2018	2020
Number of Farmers	8	3	77	156	65	35	11
Number of Cattle	47	1238	25251	9639	7234	5113	7643
Meat Production (ton)	8	1	6011	230	74	362	701
Milk Production (ton)	70	2875	10959	15113	20298	12293	21191

Figure 1. Changes in Organic Cattle Production in Turkey over the Years

As can be seen in the figure, there is a continuous increase in milk production in the country, except for 2018. There were fluctuations in the number of farmers, animals, and meat production over the years. However, the meat and milk production of the country is still considerably low compared to the EU member states. As presented in Table 2 organic cattle breeding is dominantly performed in eight provinces in Turkey (Anonymous, 2021b).

Table 2. Organic Cattle Breeding by Provinces in Turkey

Province	Number of Breeders	Number of Animals	Meat Production (ton)	Milk Production (ton)
Aydın	1	723	-	3 000
Çanakkale	2	2 786	701	1 840
İstanbul	1	7	-	-
Kastamonu	2	69	-	81
Manisa	2	2 083	-	8 147
Niğde	1	1 165	-	6 039
Samsun	1	682	-	1 836
Yalova	1	128	-	249
Total	**11**	**7 643**	**701**	**21 192**

The number of cattle raised by the 11 organic cattle breeders in 8 provinces of Turkey is 7 643. In these enterprises, 701.10 tons of red meat and 21 191.79 tons of milk were produced in 2020. Çanakkale was the only province where organic meat was produced. A significant portion (81.09%) of organic milk was produced in Aydın, Manisa, and Niğde provinces.

2. ORGANIC DAIRY CATTLE FARMING

In Turkey, on December 24, 1994, the regulation named "The Production of Plant and Animal Products through Ecological Methods" was published. Some additions were made to the relevant regulation on 29 June 1995 in order to make up for some of the deficiencies encountered in the field. In order to adapt to the developments in the organic agricultural sector and align with the changes in the EU organic agriculture legislation, the “Regulation on Principles and Implementation of Organic Farming” was published in the Official Gazette on 11.07.2002. Then, in order to be included in the list of countries exporting organic products to EU member states, the revised organic agriculture regulations entered into force after being published in the Official Gazette on 10.06.2005. Considering the problems encountered in practice and the changes in the EU legislation, some other regulations were made in following years.

2.1. Selection of Cattle for Breeding

It is highly required that the cattle selected for breeding in organic dairy cattle enterprises are resistant to the different environmental and climatic conditions and diseases. Animals that are provided from organic farms, whose genetic constitution has not been changed and fed with completely organic feeds can be used in breeding. Hence, primarily indigenous cattle breeds and their crossbreds well adapted to the region should be preferred in organic cattle enterprises. According to 2021 data, there are 18 124 106 cattle in Turkey (Anonymous, 2021c), 43.65% (7 910 489 heads) of this cattle population consists of crossbreeds and 7.85% (1 422 514) indigenous breeds. Although indigenous cattle breeds and their crossbreeds, which constitute approximately 51.5% of Turkey's total cattle presence, are low-yielding, however they have high resistance to diseases and adaptability to different environmental conditions. By using the potential of these indigenous breeds in organic meat and milk production; a) the disadvantageous situation arising from low meat and milk yield can be turned into an advantage, b) the threat of extinction in national genetic resources can be prevented, c) genetic contamination resulting from random crossings can be prevented.

Angus and Würtemberg are the breeds mainly grown for organic beef production in England and Germany, respectively (Jovanovic et al., 2011). In Italy, largely dual-purpose breeds are used in organic milk production (Gallo & Bailoni, 2012). Nevertheless, both in Turkey and the World, breeds with high genetic merit, such as Holstein, are mainly used in organic farms, as in conventional farms. However, due to the limited use of concentrate feed in the rations and the low energy and protein content of the roughage in organic farming, these breeds experience health and reproductive problems (Naute, 2012).

Organic animal farming is a pasture-based production system, and it is not possible to sustain meat and milk production successfully without suitable pasture areas. In organic farming animals must have access to pasture and open-air areas. The number of animals per unit pasture or open-air areas should be limited to provide sufficient animal manure for plant production in the enterprise. The amount of nitrogen applied via livestock manure shall not exceed 170 kg ha per year, and livestock density should be restricted by considering this requirement. In case of excessing this limit, the enterprise must acquire another area in the same region or, with the knowledge of the authorized organization, provide this area from neighboring enterprises. In the USA and some countries in EU, the grazing season of cattle older than 6 months in organic dairy farms must be at least 120 days (Ahlman et al., 2011; Mullen et al., 2013; Nehring et al., 2021) or six hours per day (Ahlman, 2010), there is an obligation to pasture and at least 30% of dry matter consumption of animals must be met from these areas.

In cases where a sufficient number of animals for breeding cannot be supplied when starting a herd for the first time for organic milk production, with the condition of being grown in accordance with the provisions of organic farming regulations, the calves can be brought from conventional farms as soon as they are weaned. Under all circumstances, the animal that will be included in the herd must be less than 6 months old. In the shortage of organically produced animals for the enlargement and/or replacement of the herd, 10% of the adult animals in the herd can be provided from conventional cattle enterprises with the approval of the Provincial Directorates every year. The animals provided through this way are entered into the conversion period. However, if the number of mature cattle is less than 10 heads in the enterprise, only 1 head is allowed in the replacement process.

2.2. Conversion Period

Conversion period refers to the lapse of time between the start of the organic animal production and the certification of animal husbandry as organic. In the conversion process from conventional to organic production, farmers have to change all their methods of animal raising, care and feeding, tillage and crop production have to be in line with the requirements of organic farming standards. In this production system, keeping animals tied is prohibited, a certain space should be allocated per animal inside and outside the barn, and animal health and welfare should be ensured in accordance with the organic farming requirements. At least 60% of the ration dry matter should consist of roughage, chemical fertilizers are not allowed, and the tillage should not cause soil erosion. Keeping the records is quite important in organic farming, and the use of chemical fertilizers, hormones, antibiotics, etc. is prohibited.

In organic farming enterprises, there are two conversion periods one is for animals and the other one is for the land to be used for feed production. The conversion period for the land and pastures where organic milk production will be made is two years. However, for the pastures, walking areas of the barns, and outdoor areas of the enterprises used for non-herbivorous animals this period is reduced to 1 year by the authorized organization. The conversion period of cattle raised for organic milk production purposes is 6 months.

2.3. Barns

In organic animal farming, barns are designed in forms and sizes that can give animals the freedom to express their natural behavior. Hence, these barns are quite different than the barns built for conventional farming systems. In organic farming, cattle are not allowed to be tied in the barn. However, in line with the animal welfare regulations, they can be kept tied for a limited time by the authorized organization by taking animal safety and welfare into consideration. In organic dairy farms, 6 m^2 and 4.5 m^2 (75% of the inside allocated area) are allocated per head inside and outside of the barn, respectively.

It is reported that foot and hoof disorders are less common in organic dairy farms since the cattle are not tied to the stalls, sufficient amount of bedding material is used on the ground, cattle spend less time in the closed barn, and at least 75% of the allocated indoor area is allocated to the walking area. (Kara & Koyuncu, 2011). In a study conducted in Sweden (Fall et al., 2008), the incidence of foot and hoof problems in dairy cattle raised under organic conditions (1.1%) was reported to be lower than in conventional farms (1.4%). In a similar study conducted in Turkey, foot and hoof problems were reported as 13% in conventional cattle farms and 2.5% in organic cattle farms (Bayram & Bingölbali, 2019).

2.4. Raising Practices

In organic dairy cattle farms, newborn calves must receive a sufficient amount of colostrum to build strong immunity. The colostrum fed to newborn calves should not be obtained from a single cow, it should preferably be mixed with the colostrum of healthy cows that gave birth recently. This practice provides passive immunity to the calves against diseases that are present but hidden in the herd. Newborn calves should not be kept in individual pens after the age of one week, they should be housed with a group of calves. In the determination of the size of these groups, characteristics such as the age, gender, developmental status, and behavior of the calves should be taken into account (Anonymous, 2010).

For strong immunity and rumen development, calves should be fed with milk for a certain period of time (90 days). The daily milk to be offered in this process should be 10% of the birth weight of the calf. With the development of the rumen in calves, resistance against diseases increases and some nutrients begin to be synthesized in the body. For this purpose, small amounts of quality forage and concentrate feed should be added to the calf rations from the 2nd week of age. In addition, after one month of age, the amount of daily milk offered to calves should be gradually decreased.

One of the most important differences between organic and conventional dairy cattle farms is the ration. The proportion of concentrate feed in the ration of cattle raised under organic conditions is limited. The proportion of concentrate feed in the ration of dairy cattle in organic farms is 40% in Turkey, 30% in Norway, and 20% in Denmark. In Switzerland, this rate is 10%, and it was reported that the proportion of concentrate feed in the rations of ruminant animals will be reduced to 5% as of 2022 (Schori & Münger, 2021). Since the feeding of cattle is based on pasture, and a limited amount of concentrate feed is used in the organic farming system, some declines are expected in growth and development and in the age at first breeding compared to conventional farms (Bayram et al., 2013). The age of first calving in organic and conventional dairy cattle farms were reported as 26.8 and 26.9 months by Kristensen & Kristensen (1998), and 27 and 29 months by Naute et al. (2006), respectively. These studies indicate that the organic farming system does not have a negative effect on the age at first breeding. Furthermore, in a similar study conducted in Turkey, the age at first breeding was reported as 608.4 and 584.0 days in Holstein Friesian cattle raised under organic and conventional conditions, respectively (Demirhan & Ünal, 2016). In another study conducted in Norway it was reported that there was no difference between the two breeding systems in terms of the number of inseminations per pregnancy (Reksen et al., 1999). In another study conducted in the same country (Garmo et al., 2010), the number of open days was reported as 94.6 and 95.3 in dairy cattle raised under organic and conventional conditions, respectively. In addition, Bayram et al. (2008) reported the number of open days as 146.6 and 178.1 for organic and conventional dairy farms, respectively, while Demirhan & Ünal (2016) reported these numbers as 104.1 and 111.1 days in the studies they conducted in Turkey. The calving interval in organic and conventional dairy farms were reported as 388 and 390 days by Valle et al. (2007) respectively, also it was reported as 433 and 405 days respectively in a study conducted in Turkey (Bayram & Bingölbali, 2019).

2.5. Feeds and Animal Nutrition

In organic dairy farms, all cattle must be fed with organically produced roughage and concentrate feeds. The rations prepared must fully meet the nutritional needs of all the cattle in different physiological stages. Force-feeding of animals is prohibited, and feeding programs should aim at increasing the quality of the product to be obtained, as well as increasing production. In organic farms, the aim must be to produce the feeds within the enterprise by combining the plant and animal production together thereby reducing the input costs. In order for the production to be profitable in organic dairy cattle enterprises, enterprises must possess meadow and pasture areas where the cattle can graze at different seasons of the year. Animals of the enterprises who have adequately large meadow and pasture areas will be healthier and production costs of organic farming will be cheaper in these enterprises.

According to the current organic agriculture regulation in Turkey, the rations in dairy cattle enterprises should consist of 60% roughage and 40% concentrate feed on the basis of dry matter. However, under the supervision of the authorized organization, the proportion of the concentrate feed can be increased to 50% for the first three months due to the intense energy needs of the newborn cows. The feed produced in the conversion period can be used in the rations of the cattle but its proportion cannot exceed 30% on the dry matter basis. If the feed produced in the conversion period is obtained from the enterprise where the animals are being raised this rate can be increased up to 60%. The use of antibiotics, coccidiostats, medicinal products and substances that promote growth or increase yield are prohibited in animal nutrition in organic livestock production (Anonymous, 2010).

2.6. Animal Health and Welfare

In organic animal farming, hygienic conditions should be provided in the barns. In the case of health problems, firstly alternative medicine techniques that do not leave residues in animal products, phytoremediation (plant extracts, herbal teas and herbal essential oils) or homeopathy (certain substances of animal and vegetable origin, the toxins of which have been diluted and distilled) treatment methods should be used (Anonymous, 2010). In the event that these methods are insufficient in the fight against diseases and to prevent the animals from suffering, chemical compounds and/or antibiotics can be used for treatment with the permission of the authorized organization. Except for vaccinations, parasites, animal diseases and pest control programs, products obtained from animals administered more than three chemical drugs or antibiotics in a year cannot be sold as organic. These animals can be taken into the conversion period again with the permission of the authorized organization. One of the primary purposes of organic livestock breeding is to ensure the continuation and improvement of the health and welfare of animals. In order to protect animal health, hygienic measures such as disinfection and vaccinations are allowed with the recommendation of veterinarians (Anonymous, 2010).

In organic dairy farms, cattle are expected to be healthier and superior in terms of welfare as a result of the barn environment where they can exhibit their natural behaviors, the freedom of movement that allow them to exercise more, and the low concentrate feed level in the ration. Many studies were conducted to reveal the differences between organic and conventional farms in terms of the health of the cows. These studies predominantly focused on mastitis, metabolic diseases, somatic cell count, udder health, and parasitic diseases. The obtained results can be summarized as follows:

Mastitis is a disease that threatens animal health and causes serious economic losses in organic dairy cattle enterprises as well as in conventional enterprises (Hamilton et al., 2006). In the majority of studies, lower mastitis incidences were reported in cattle raised under organic conditions compared to conventional farms (Hardeng & Edge, 2001; Bennedsgaard et al., 2003; Sato et al., 2005; Hamilton et al., 2006; Valle et al., 2007; Bayram & Bingolbali, 2019). In contrast, Fall et al. (2008) reported that there was no difference between the two raising methods in their studies. In addition, Byström et al. (2002) reported a higher incidence of mastitis in cattle raised under organic conditions.

In the most of the studies comparing the health status of cattle raised under organic and conventional conditions, organic cattle showed better performance, but there are studies that contradict these reports. Kijlstra et al. (2006) stated that, except for metabolic diseases, there is no strong scientific evidence to support that the health and well-being of cattle raised under organic conditions are always better or worse and additional studies are needed to come to a definite conclusion.

In a study conducted in Sweden, the most common problems resulting in the culling of Holstein Friesian cattle were mastitis (26.7%), low fertility (23.0%), and low milk yield (8.3%) in organic cattle farms. In conventional farms, low fertility (25.9%), mastitis (20.6%) and low milk yield (9.8%) were the top causes of culling (Ahlman, 2010). In a similar study conducted in Canada (Rozzi et al., 2007), the most important factors causing culling in organic dairy cattle farms were determined as udder health (30.7%), low fertility (21.9%) and low milk yield (5.6%), while in conventional farms these causes were low fertility (24.8%), udder health (22.5%) and low productivity (12.2%). As it can be deduced from the above-mentioned results of the studies, although the order of the problem may change in conventional and organic dairy cattle farms, mastitis, low fertility, and low milk yield were the most common causes for culling in dairy cattle farms. In the study carried out by Bayram & Bingölbali (2019) in Turkey, it was revealed that the factors causing the culling of Holstein cattle raised under organic conditions were low fertility and mastitis, while they were low fertility and foot and hoof disorders under conventional conditions.

3. COMPARISON OF MILK PRODUCED UNDER ORGANIC AND CONVENTIONAL CONDITIONS IN TERMS OF QUANTITY AND NUTRITIONAL CONTENTS

3.1. Comparison of Milk Production

Milk yields of cows raised under organic conditions (actual, 305 days, daily) were reported to be 10.0% to 35.4% lower than those reared conventionally (Hardeng & Edge, 2001; Rosati & Aumaitra, 2004; Sato et al., 2005; Sundberg et al., 2009; Bermudez et al., 2017). In many studies, the reasons for the low milk yield of cattle in organic dairy farms were reported to be the limited use of concentrate feed and the high level of roughage in the ration which contains low protein and energy (Rosati & Aumaitra, 2004; Roesch et al., 2005; Naute et al., 2006).

3.2. Comparison of Nutrient Content

In a meta-analysis study conducted by Palupi et al. (2012) it was reported that organic milk had higher protein content (0.56±0.24) than conventionally produced milk. In a similar study conducted in the same period, Capuano et al. (2013) reported that the protein content of organic milk can be higher as a result of using more nitrogen-containing manure in organic feed production, since the use of chemical fertilizers is prohibited. In addition, Kourimska et al. (2014) reported that organic milk has lower protein content as a result of low starch consumption resulting from the use of limited concentrate feed in the ration.

Palupi et al. (2012) reported that organic milk had a higher percentage of fat (0.21±0.08) than milk produced in conventional farms. This difference was attributed to the abundant consumption of fresh green grasses in the ration of the cows in the organic dairy cattle farms by Capuano et al. (2012). The fatty acid profile of milk obtained from farm animals has a significant impact on human health. Saturated fatty acids (SFA), which constitute an important part of the fatty acids of milk, have many negative effects on human health, especially cardiovascular diseases. On the other hand, monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) have positive effects on human health (Shingfield et al., 2015; Butler et al., 2010). Fatty acid contents of animal products vary depending on the nutrients consumed by animals, for this reason, dairy cattle rations should be prepared in such a way as to reduce saturated fatty acids and increase unsaturated fatty acids of the milk (Shingfield et al., 2015).

In some studies, comparing saturated and unsaturated fatty acid contents of milk obtained from organic and conventional farms, organic milk was reported to contain lower saturated and higher unsaturated fatty acids (Butler et al., 2008; Butler et al., 2010; Lavrencic et al., 2017). This is because of the higher fresh green grass as well as roughage consumption of animals in organic dairy farms.

In the meta-analysis study conducted by Palupi et al. (2012), it was reported that milk obtained from organic farms had higher conjugated linoleic acid (0.68±0.13) and Omega-3 (0.84±0.14) levels compared to the milk produced conventionally. This difference results from the high level of fresh green grasses in the ration of cattle in organic farms (Capuano et al., 2012; Palupi et al., 2012). In addition, Bergamo et al. (2003) reported that the milk of cows fed with high amounts of fibrous feeds contain higher level of Conjugated Linoleic Acid, which has many positive effects on human health.

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CHAPTER 4

ORGANIC BEEF FARMING

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INTRODUCTION

The need for organic red meat emerged in the 1950s when conventional beef cattle producers began to use both natural and synthetic hormones in meat production. Conventional producers reported that they preferred these practices because beef cattle could reach the target body weight in a shorter time and send them to the market faster. On the other hand, in 1955, to meet the demand of the "fast food" sector, conventional producers started to use antibiotics in feed to keep their cattle healthy, protect them from diseases and improve feed efficiency. In the early 1990s, the use of genetically modified feeds (GMOs) in animal nutrition also caused public reactions again (ATB, 2015).

Consumers pay more attention to their food sources and content, primarily due to the prevalence of deadly diseases such as cancer, which are difficult to treat and sometimes even impossible, and diseases like Bovine Spongiform Encephalopathy (BSE) occur with conventional feeding. For these reasons, the importance of health criteria in product quality besides the number of animal products has created an important reason for beef cattle producers to switch to organic red meat production. In particular, in countries such as the European Union (EU), producers have again turned to organic meat cattle production to support organic agricultural areas further. In addition, animal welfare and environmental protection are also essential factors in the beginning and spread of organic animal production. Organic animal production is an animal production in which synthetically produced substances are not used directly or indirectly, each stage of which is controlled and certified according to the principle of organic feed feeding and healthy animal breeding (Koyubenbe & Konca, 2012).

In this study, the current situation of organic beef cattle breeding in European countries and Turkey, organic breeding standards, and organic and conventional production systems in beef cattle breeding were compared with some characteristics.

1. ORGANIC BEEF IN EU

From 2013 to 2019, developments in member countries differ in the number of organic cattle. Although the number of certified organic cattle in Croatia, North Macedonia, and Greece has the most significant increase (230%, 163%, and 101%) among all Member States, Germany, France, and Austria occupy the first three places in a number. When we look at the number of organic cattle in Turkey, it is noticeable that there was a 90.04% decrease in the same period (Table 1).

Table 1. Number of Certified Organic Bovine Animals (Head) in EU and Turkey (Eurostat, 2021)

	2013	2014	2015	2016	2017	2018	2019	2013-2019 Variation (%)
EU (28)	3 552 014	3 630 538	3 636 091	3 997 266	4 310 740	4 605 744	4 817 726	35.63
Belgium	76 214	76 620	80 405	88 787	108 016	106 049	107 690	41.25
Bulgaria	1 311	1 344	4 209	9 718	10 400	9 314	9 402	64.16
Czech Republic	213 303	224 873	237 635	246 684	255 978	262 061	262 910	23.26
Denmark	181 508	182 131	157 527	164 397	199 870	220 754	224 348	23.6
Germany	621 800	643 600	654 386	700 356	788 561	771 320	870 372	39.98
Estonoia	30 017	32 149	34 312	36 774	40 049	41 499	42 290	40.89
Ireland	37 473	38 923	46 946	52 742	56 873	61 819	64 093	71.04
Greece	*71 034*	*70 346*	*68 454*	*75 132*	*81 425*	*138 015*	*142 609*	*100.76*
Spain	151 571	168 214	190 224	199 737	207 121	212 066	215 802	42.38
France	550 121	541 129	541 312	573 623	649 856	751 382	830 921	51.04
Croatia	*6 540*	*7 308*	*7 002*	*14 442*	*17 226*	*19 613*	*21 551*	*229.53*
İtaly	231 641	222 924	266 576	331 431	336 278	375 414	389 665	68.12
Latvia	71 707	76 048	80 400	92 546	95 585	96 423	99 041	38.12
Lithuania	34 163	35 279	34 929	37 814	57 270	57 884	58 356	70.82
Luxembourg	3 373	3 459	3 576	3 873	4 177	4 956	4 814	42.72
Hungary	19 273	18 871	18 919	20 815	17 741	18 964	27 007	40.13
Netherlands	53 704	53 603	56 264	60 150	65 189	71 715	71 817	33.73
Austria	376 973	376 647	266 236	404 648	422 008	421 324	420 693	11.6
Poland	44 663	38 744	31 896	29 107	27 901	26 953	30 186	32.41
Portugal	69 095	74 343	97 320	80 152	86 881	93 191	95 306	37.93
Romania	20 113	33 782	29 313	20 093	19 339	16 872	19 358	3.75
Slovenia	25 168	27 359	30 592	33 397	35 095	35 751	37 126	47.51
Slovakia	43 142	44 772	58 945	65 724	55 906	63 340	61 432	42.39
Finland	49 101	52 395	59 700	61 942	68 197	72 082	76 173	55.14
Sweden	285 670	281 320	285 774	296 260	307 120	332 294	333 245	47.57
Norway	28 875	27 385	28 516	29 329	29 931	30 307	28 361	-1.78
Switzerland	162 059	167 024	170 420	175 520	187 745	200 450	205 389	26.74
England	283 336	304 355	293 138	296 572	296 172	324 202	300 788	6.16
N. Macedonia	*2 726*	*2 133*	*4 401*	*3 368*	*4 698*	*6 390*	*7 170*	*163.01*
Serbia	1 853	2 557	2 593	2 560	2 474	3 594	3 556	91.91
Turkey	*47 715*	*9 746*	*8 234*	*7 234*	*6 632*	*5 113*	*4 751*	*-90.04*

There is a total of 1 205 092 head of organic beef cattle in the EU (28) for 2019, and the total organic beef cattle presence has increased by approximately 45% between 2013 and 2019. Countries reporting significant organic meat cattle presence are France (272 153 heads), Spain (199 661 heads), Denmark (120 549 heads), England (88 198 heads), and Portugal (87 492 heads). Countries reporting significant organic meat cattle presence are France (272 153 heads), Spain (199 661 heads), Denmark (120 549 heads), England (88 198 heads), and Portugal (87 492 heads). As can be seen in the table, it is seen that Turkey ranks last in the EU in terms of the number of certified organic beef cattle when compared to other countries (Table 2).

Table 2. Number of Slaughteed Organic Cattle in EU (28) (Head) (Eurostat, 2021)

	2013	2014	2015	2016	2017	2018	2019
EU (28)	833 197	846 216	919 533	1 020 616	1 053 860	1 260 887	1 205 092
Belgium	1 833	4 455	3 480	3 010	6 479	6 605	7 235
Bulgaria	536	547	1 769	5 370	4 699	5 929	6 060
Czech Republic	13 468	13 773	12 761	12 977	14 286	20 169	18 089
Denmark	94 729	95 617	82 096	85 800	105 062	116 218	120 549
Germany	63 400	65 600	68 049	75 500	81 587	81 619	93 813
Estonia	18 163	18 269	19 088	20 057	22 087	22 854	23 645
Ireland	10 445	12 772	12 135	15 046	10 873	15 284	15 968
Greece	22 774	23 003	24 150	26 002	17 352	49 303	54 361
Spain	130 957	158 524	177 164	186 232	190 724	196 461	199 661
France	143 966	140 097	151 602	147 562	166 768	192 561	272 153
Croatia	2 721	2 270	858	2 509	2 753	1 811	1 599
İtaly	81 904	69 786	103 299	145 307	144 626	167 032	:
Latvia	16 396	16 307	20 018	24 601	27 111	28 978	31 536
Lithuania	12 023	13 889	6 091	9 334	10 416	11 347	11 894
Luxembourg	467	520	523	538	590	808	891
Hungary	15 335	14 585	14 199	14 769	11 436	13 482	22 348
Netherlands	10 601	9 641	7 689	8 285	8 806	8 926	8 831
Austria	:	4 397	25 773	32 988	20 524	21 071	22 085
Poland	19 871	11 653	9 144	8 433	8 096	7 486	8 320
Portugal	:	:	:	8 136	16 440	87 103	87 492
Romania	1 101	244	491	478	481	701	426
Slovakia	8 520	8 725	14 346	17 980	67	14 303	32 551
Finland	17107	18 008	21 141	23 021	25 288	26 125	29 551
Sweden	38 848	37 146	39 081	43 865	43 999	47 188	46 565
England	97 461	104 730	102 418	98 699	111 342	116 129	88 193
Serbia	0	:	0	10	470	1112	1 264
Turkey	***10 751***	***1 658***	***2 168***	***4 107***	***1 498***	***282***	***:***

(:) not available.

When the organic red meat production activities in the European Union countries are examined in Table 3, it is seen that the first three countries with the highest production amount in the EU-28 are France, England, and Spain. On the other hand, Turkey ranks 18th with 819 tons of organic red meat production.

Table 3. Organic Red Meat Production in EU (28) (Tons) (Eurostat,2021)

	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Belgium	:	:	:	5 502	7 321	8 708	9 601
Bulgaria	0	0	0	373	212	969	187
Czech Republic	10 329	6 674	6 719	6 752	6 697	7 291	7 867
Denmark	14 229	:	14 305	16 818	16 254	6 643	17 835
Estonia	1 634	1 804	2 221	2 209	2 878	3 404	2 636
Ireland	943	1 139	1 337	1 555	1 550	2 361	2 338
Greece	521	610	874	675	801	839	977
Spain	24 250	24 601	28 849	26 487	26 417	35 803	41 265
France	:	41 773	44 769	50 175	55 694	68 948	78 808
Croatia	9	109	1 225	1 774	1 725	2 311	2 602
Cyprus	10	15	19	22	23	28	17
Latvia	3 463	2 784	2 700	1 582	1 604	1 629	1 283
Lithuania	2 798	3 758	4 060	284	365	803	1 098
Luxembourg	135	127	120	145	150	187	290
Hungary	894	982	888	1 376	1 123	1 110	1 812
Netherlands	12 417	9 750	8 961	9 547	11 380	11 976	13 278
Poland	150	24	3	8	2	0	23
Romania	6	0	0	0	1	8	26
Slovenia	:	200	152	324	327	410	330
Slovakia	73	137	130	175	237	66	53
Finland	2 870	3 100	4 150	4 360	3 780	3 710	3 770
Sweden	23 668	24 593	25 075	26 568	26 877	29 750	30 914
Iceland	:	:	:	:	:	23	29
Norway	2 381	2 439	2 442	2 630	3 013	3 101	2 849
England	54 100	49 700	46 400	47 200	53 000	53 800	42 500
Serbia	0	3	60	65	27	14	44
Turkey	***4 970***	***2 107***	***2 605***	***1 609***	***1 352***	***1 688***	***819***

(:) not available.

While the highest organic beef production among EU countries is in France (31 973 tons/year), Spain (26 091 tons/year), and England (24 000 tons/year). Turkey ranks 15th among 16 countries with beef production (Table 4).

Table 4: Organic Beef Production in the EU (Tons) (Eurostat,2021)

	2013	2014	2015	2016	2017	2018	2019
Belgium	:	:	:	918	1 976	2 015	2 207
Bulgaria	:	:	:	263	152	866	140
Czech Rep.	9 460	5 841	5 938	6 063	6 027	6 547	7 095
Denmark	6 226	6 160	5 175	5 502	5 764	6 643	6 827
Estonia	1 346	1 516	1 945	1 853	2 523	3 071	2 273
Spain	14 240	15 090	18 072	15 911	16 641	23 004	26 091
France	:	16 783	18 906	22 441	24 949	29 388	31 973
Croatia	:	75	811	1 100	1 133	1 456	1 358
Luxembourg	67	69	66	88	90	116	226
Netherlands	2 862	2 736	2 076	2 237	2 378	2 410	2 384
Finland	1 960	2 130	2 950	2 910	2 620	2 610	2 670
Sweden	18 398	19 103	18 887	19 088	19 290	21 806	22 382
Norway	1 237	1 273	1 379	1 485	1 583	1 603	1 382
England	30 700	28 500	27 800	26 800	30 300	31 600	24 000
Serbia	:	:	:	60	27	11	30
Turkey	***3 126***	***231***	***459***	***74***	***86***	***362***	***122***

(:) not available.

2. GENERAL PRINCIPLES OF ORGANIC BEEF PRODUCTION

This section outlines these and other critical guiding principles, practical implications, and constraints in planning, converting, and developing a successful organic beef production system. In addition, aspects of organic certification standards relating to beef production are included; however, specific details must be confirmed with the organic certifier (TOB, 2010).

2.1. Breeder Selection

- The cattle to be selected as breeding stock for organic meat production must be resistant to the environment, climatic conditions, and diseases. For this purpose, native breeds adapted to the region and their hybrids should be preferred.
- Culture breeds that adapt to the region can also be used, but genetically modified animals are prohibited.

- In organic animal breeding, the genetic structure of animals cannot be changed, and animal breeding using gene technology methods is not allowed.

2.2. Transition Process

- Calves to be brought from conventional farms for the first time to form a herd should be at the age of 6 months at the most.
- The transition period of the existing conventional beef cattle enterprises to organic beef production is 12 months. However, this period is 3/4 of the life span for animals separated from the herd for meat purposes in organic dairy cattle farms.

2.3. Cattle Barns

- Animal shelters are built from sanitary building material; the conditions of the shelter meet the biological and racial needs of the animals. Animals should have easy access to feed and water. Insulation, heating, and ventilation of buildings; airflow, dust level, temperature, relative humidity, and gas density will be kept within limits that will not harm animals. Barns should allow plenty of natural ventilation and light penetration.
- Free-range areas, open-air promenades, or open shelter areas; adequate protection against rain, wind, sun, and extreme heat should be provided, depending on local weather conditions and the species involved.
- Barns should create an area for the cattle to relax and exhibit their natural behavior and provide a suitable and workable environment

for the keepers. It should allow the obtained products to be obtained, processed, and stored under hygienic conditions. As a result of keeping cattle in cramped environments in conventional barns, stress hormones are secreted, which weakens the immune system of the animals and causes them to get sick more easily. In organic cattle breeding, a particular area per animal must be allocated in the barn, and a walking area for 75% of this area must be allocated. The net area to be allocated to cattle is 5 m^2/head for breeding and fattening cattle, and the free circulation area outside the pasture is 3.7 m^2/head (TOB, 2010).

- In regions where favorable climatic conditions allow animals to live outdoors, it is not mandatory to build animal barns.
- The substrate consists of a stalk-straw or other suitable natural material.

2.4. Breeding Practices

- While re-establishing the herd in the enterprise where organic cattle fattening is carried out, first of all, from organic livestock enterprises, if not found, fattening calves following the organic agriculture regulation should be obtained from conventional livestock enterprises.
- If organically produced animals cannot be found for the enlargement of the herd and/or the renewal of the herd, a maximum of 10% of the adult bovine animals in the existing herd can be brought from the conventional livestock enterprises with the approval of the provincial directorate every year. The

transition process is applied to the brought animals. These rates can be increased up to 40% with the approval of the provincial directorate in the following cases:

1) The operator's written commitment guarantees the increase in herd size.
2) The race is changed.
3) New animal production is being developed.
4) The animal breed on the farm is in danger of extinction.
5) There is high animal mortality due to health or disaster reasons.

- If there are less than 10 cattle in the enterprise, the above rates (10% and 40%) are not applied. Herd renewal operations at these enterprises are limited to a maximum of 1 animal per year.
- Animals cannot be kept tied up. However, animals may be allowed to be tied up for a limited period, provided that an enterprising obligation is demonstrated for the safety and welfare of the animals by the institution authorized by taking into account the animal welfare regulations.
- Groups of 10 heads or less of cattle, if it is not possible to keep them in the group under their behavioral needs, may be bound with the approval of the authorized organization, provided that they reach grazing areas and open ban areas or exercise areas at least twice a week.
- If cattle have access to pastures during grazing periods and winter shelters give animals freedom of movement, the obligation to

provide outdoor promenades and open spaces for animals in winter may be lifted.

- However; Bulls older than one year should have access to pastures, open promenades, and open spaces. In the last food period, cattle can stay indoors, provided that they do not exceed 1/5 of their life span and not more than three months.

2.5. Feeds and Animal Nutrition

- All animals should be fed with coarse and coarse feeds produced entirely organically in organic production.
- For the production to be economical in organic farms, there must be meadow and pasture areas belonging to the enterprise so that the cattle can reach the pasture areas at different times of the year. Having adequately sized meadows and pastures in organic production farms ensures that the cattle are healthier and reduces the cost of the product obtained (Bayram et al., 2013).
- Ecological meat production is based on pastures, and it does not seem possible for this system to run successfully without suitable pastures. In many countries, cattle must reach the pasture in organic animal production. In the organic agriculture regulation available in Turkey, it is stated that "animals are provided with the opportunity to reach pastures at different times of the year", and there is no precise time required for access to pastures. In all meat cattle rations, coarse feeds such as silage and fresh dry grass should be at least 60% of the dry matter of the ration. In the event of a decrease in feed production due to natural disasters, the use

of conventional feedstuffs in animal nutrition is allowed in the disaster area for a short time at a rate to be determined by the Ministry.

- Antibiotics, coccidiostats, medicinal products, and other substances that increase growth or production cannot be used in animal nutrition.
- Feedstuffs, feed additives, feed processing aids, and animal feeding products; cannot be produced using genetically modified organisms or products derived from them.

2.6. Animal Health

- Artificial insemination is allowed, but natural reproduction should be encouraged.
- Disease prevention measures should be applied in organic animal breeding. For this reason, preventive medicine is essential in organic animal breeding and animal health. When starting organic meat production, breeds and breeders resistant to diseases and well adapted to the region should be preferred. For regular exercise to increase the animals' natural immunity, access to the walking areas or pastures and the use of quality feed should be provided. In addition, appropriate placement density should be provided to prevent health problems in animals due to overcrowding.
- If an animal becomes ill or injured despite all preventive measures, it should be isolated in a suitable shelter and treated immediately.

- Veterinary medicinal products can be used in organic livestock farming under the supervision of a veterinarian. Instead of chemically synthesized allopathic medical, veterinary products or antibiotics, the products and phytotherapeutic products allowed in the regulation can be used, provided that they have a therapeutic effect on the animal species to be treated. In cases where the use of the substances allowed in the regulation is insufficient to fight disease or injury, and for treatment, chemical composition drugs or antibiotics can be used in a controlled manner with the permission of the authorized institution.
- Chemically synthesized veterinary medicinal products or antibiotics cannot be used for disease prevention applications.
- Genetically modified organisms cannot be used as inputs in organic animal production. In addition, the use of growth or production-enhancing substances and hormones or similar substances to control reproduction or other purposes is prohibited. However, for therapeutic purposes, hormones can be given to sick animals as a veterinary practice.
- When using veterinary medicinal products, the diagnosis, the intervention method, the dose of the drug, the drug's active substance, the duration of treatment, and the product used together with the residual purification time of the drug should be recorded.
- The period between the last application of veterinary medicinal products given to an animal under normal conditions and the date of obtaining organic products from these animals is twice the

application in conventional farming in organic farming or 48 hours in cases where no residue purification period is specified.

- Current vaccination practices, parasite treatment, or designated as mandatory programs to combat animal diseases and pests, except for Turkey, an animal, or animal veterinary medicinal products or antibiotics within a year three more than the group they are applied in the case of chemically synthesized or productive life that is treated animals with the duration of less than one year more than once if he saw the animals or the animals in question could not be sold as organic products, and re-migration process are included. The entrepreneur must keep records of this.
- In the event of a notifiable contagious and epidemic disease occurring in the area where the enterprise is located, apart from the national compulsory control programs, the provisions of the Veterinary Services, Plant Health, Food and Feed Law No. 5996, and other relevant legislation should be followed, and veterinary biological substances that provide immunity should be used.

2.7. Transport and Slaughter

The following regulation rules should be applied for the transportation and slaughter of organic beef cattle.

- Animals should be transported without stress and in a short time. Loading and unloading operations should be carried out carefully and without using an electrically stimulating device to force the animals. It is forbidden to use any sedative drugs before and during transportation.

- A break is made every 8 hours for feeding, watering, and resting in land transport.
- Animal health and surveillance Law No. 3285 and other relevant legislation are applied for all kinds of animal transports in the country and abroad.
- Butchering animals are treated so as not to cause stress during slaughter. Where possible, separate slaughterhouses and integrated meat plants are used. In cases where it is not possible, organic animals are slaughtered after the slaughter of conventionally raised animals, then the slaughterhouses and integrated meat plants are cleaned with the substances allowed in this organic agriculture regulation.

3. COMPARISON OF MEAT YIELDS IN CONVENTIONAL AND ORGANIC CATTLE FARMS

It is not easy to compare organic and conventional meat cattle breeding enterprises in terms of various characteristics. Because there are significant differences between both systems and within each system itself. Therefore, when comparing organic and conventional systems, the operating conditions of the countries and the region within the country should be taken into account (Alapala & Ünal, 2009).

Woodward and Fernandez (1999) studied the fattening performance of castrated Simmental x Angus crossed wheat under conventional and organic conditions. As a result of the research, the daily live weight gain, dry matter consumption, and feed efficiency performance of the grains fed under conventional and organic conditions were found as 1.66-1.40

kg/day, 8.67-8.56 kg/day, 6.09-7.58 kg dry matter/kg body weight gain, respectively.

Gallo & Bailoni (2012) found the carcass's meat, fat, and bone ratios to be 69.0%-64.08%, 2.90%-7.36%, and 28.10-28.56% in organic, conventional beef cattle, respectively, in their fattening study conducted with 6-month-old Simmental calves. Their study stated that the difference between the other two parameters except bone was significant.

4. QUALITY OF BEEF PRODUCED IN CONVENTIONAL AND ORGANIC FARMS

Organic meat production and consumption are becoming increasingly widespread globally due to prioritizing the health factor. It is noted that organic meat is richer in omega-3 fatty acids and *conjugated linoleic acid (CLA)* than conventional meat and is juicier, crisper, more aromatic from a sensory point of view. Furthermore, it is reported that the balanced ratio of essential fatty acids is associated with a lower incidence of cancer, heart disease, diabetes, obesity, and mental disorders (Tekeli, 2005).

They reported that meat obtained from cattle raised under organic conditions had less fat and contained less cholesterol than conventionally raised cattle (Hansson et al., 2001; Miotello et al., 2009). The fatty acid content in animal products is as vital as the fatness ratio, and the high omega-3 fatty acids increase the product quality.

Ribas-Agusti et al. (2019) in the samples taken from *M.Longissimus Dorsi* (MLD) and *M. Supraspinatus* muscles, the meat of cattle raised under organic conditions has 17% less cholesterol, 32% less fat, 16% less fatty acids, 24% less singleton meat than conventional meat. Unsaturated fatty acids, 170% more α-linolenic acid, 24% more α-tocopherol, 53% more β-carotene, 34% more coenzyme Q10, and 72% more taurine amino acids.

Miotello et al. (2009) investigated the meat quality of organic and conventionally raised Simmental calves. They examined meat's color, fatty acid composition, and chemical properties by taking samples from the 8th rib and MLD muscles from the carcasses. It was determined that organic calves had significantly lower fat content ($P<0.01$) and cholesterol content ($P<0.05$) in the 8th ribs compared to conventional calves, while cooking weight losses and ether extract were significantly lower ($P<0.001$) in meats. In addition, they reported that the red index value was higher in organic calves due to high hemic iron content ($P<0.001$). They found positive nutritional value in organic beef meat in terms of n-3 fatty acids, n-6/n-3 ratio, and CLA content. It has been reported that organic beef has low levels of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), n-3 polyunsaturated fatty acids (PUFA), and n-6 MUFA in terms of the composition of fatty acids (Pastushenko et al., 2000).

Revilla et al. (2021), in their study examining the effects of animal age, roughage consumption, and production systems (conventional and organic) on meat quality, stated that the intramuscular fat content was higher in carcasses obtained from the organic production system. In addition, their studies found that the moisture and MUFA content in meat is low. They found that organic meat has a darker color. It has been reported that organic beef samples were significantly higher ($P > 0.05$) in fat content and therefore were significantly ($P > 0.05$) lower in moisture content than conventional beef samples (Walshe et al., 2006). It has been stated that the content of n-3 PUFA, DHA (Dekosahegzaenoik Acid), and EPA (Eikosapentaenoik Acid) in organic meat is high, and the amount of n-6 PUFA is low (Enser et al., 1998).

Blanco-Penedo et al. (2010) reported no significant difference in terms of cadmium, arsenic, mercury, and lead in meat obtained from calves raised in organic, conventional, and intensive systems.

5. COVID-19 IMPACT ON ORGANIC BEEF MARKET

The Covid-19 pandemic has affected absolutely all aspects of the daily life of the world's population. In particular, it has affected their eating habits or contributed to the change of lifestyle of a large number of people. Since food consumption is critically important for humans, it has become an important area of research regarding the effects of the COVID-19 pandemic.

The rapidly developing nature of the COVID-19 virus has created many problems for the meat industry. Restrictions on the export of animals, logistical restrictions, the closure of slaughterhouses, restaurants, and food services have negatively affected all meat supply chain stages. Organic beef is an emerging market in the food and beverage industry due to the rapid growth of organic food consumption in recent years. Organic beef has become one product that contributes to consumer safety and a healthy lifestyle. The COVID-19 pandemic has partially affected the supply of raw materials, the production of processed organic cattle, and other related activities. In addition, organic beef production was negatively affected during the worldwide quarantine. However, the opening of economic activities is seen as a potential growth opportunity for the organic beef market in the coming months and years.

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CHAPTER 5

ORGANIC SHEEP AND GOAT FARMING

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INTRODUCTION

It is reported by many researchers that the demand for animal products in the world will increase significantly in the coming years. The increase in animal production to meet this demand will also create some important problems. At the beginning of these problems is the effect of livestock sector on global climate change, and there are other problems such as the increase in the number of animals per farm due to the intensification of production systems, animal welfare concerns, the increase in the rate of spread of diseases, the use of more antibiotics and the disruption of access to healthy and safe food (Berckmans, 2014; Grossi et al., 2019; Tullo et al., 2019).

In order to solve these problems, especially by the European Union (EU) puts several action plans into practice. Among these, there are action plans that are known as the European Green Deal presented in 2019, which mainly aim to expand sustainable production systems using nature-friendly green technologies and to zero carbon emissions in the next future. As stated in the aforementioned deal, organic agricultural production is at the forefront of environmentally friendly agricultural production systems. According to the Codex Alimentarius Commission, organic agriculture is a holistic production system that aimed at protecting and enriching the health of the agro-ecosystem, biodiversity, biological cycles and biological activity of soil. Thus, it is assumed that people contribute to healthier nutrition, protection of the ecosystem, creating employment and ensuring rural development at significant levels (Chander et al., 2011).

Certified organic sheep and goat production have been growing in many countries in the world including EU countries. One of the most important factors of growing of these sectors is increasing of consumer demand to these organic products even though its high price (Pehlivan et al., 2020). According to the latest data, the contribution of organic sheep and goat production to the general economy is very low in Turkey. For all that, there are many opportunities to develop organic sheep and goat production in Turkey. By making good use of these opportunities and by making accurate plans and practices, it will be possible to increase the development of these sectors and thus their contribution to the country's economy in the near future.

1. ORGANIC AGRICULTURE IN THE WORLD

Global organic agricultural production has grown significantly in recent years. According to 2019 data, this sector has become a production branch made by 3.1 million producers on 72.3 million hectares of land in 187 countries around the world. The total organic agricultural production value, which was 15.1 billion euros in 2000, reached 106.4 billion euros in 2019. The leading countries in terms of production value are the USA (44.7 billion Euros), Germany (12 billion Euros) and France (11.3 billion Euros) (Willer et al., 2021).

2. ORGANIC ANIMAL PRODUCTION IN THE WORLD AND IN THE EUROPEAN UNION (EU)

2.1. Organic Animal Production in the World

The data on organic animal production in the world is insufficient and the statistics in recent years have not been reached. However, it is also known that the organic livestock sector is growing in the world (Willer et al., 2021). For example, in many European countries, organic milk and eggs have managed to make up 10% and 20% of the total market for these products, respectively. Besides, some Latin American countries such as Brazil and Argentina are able to export organic beef to the EU and the USA. However, the organic dairy sector showed faster and stronger growth rates than the organic meat sector (Harris et al., 2003; Chander et al., 2011)

According to the 2012 statistics (latest data available), the numbers of organic certified bovine, sheep, pig and poultry in the world are approximately 4.6, 5.6, 1.0 million heads and 73 million, respectively, and these figures represent 3%, 0.5%, 0.1% and 0.3% of the total number of animals of the same species in the world, respectively. Globally, significant increases were observed in organic certified animal numbers between 2007 and 2012. The most significant increase occurred in the number of poultry (127%) and followed by bovine (71%), pig (65%) and sheep (34%) (Table 1).

Table 1. Organic Certified Animal Numbers between 2007-2012 Years in the World (Willer et al., 2014)

Species	2007	2008	2009	2010	2011	2012	Changes (2007-2012) (%)
Bovine	2 682 144	3 059 068	3 457 549	3 513 268	4 582 779	4 582 910	+ 70.9
Sheep	4 224 160	4 019 186	4 892 185	4 661 428	5 413 645	5 642 683	+ 33.6
Pig	649 822	695 182	686 330	777 606	1 014 497	1 072 410	+ 65.0
Poultry	31 963 268	42 261 451	41 150 344	53 388 092	69 940 909	72 594 657	+ 127.1

Organic animal production in the world is concentrated mainly in Europe and North America. Respectively, 70%, 80% and 77% of organic cattle, sheep and pigs are in Europe and 53%, 44% of poultry are in North America and Europe, respectively (Willer et al., 2014). The first three countries with the highest organic of bovine, ovine, pig and poultry in the world are respectively; China, USA, France; Argentina, England, Italy; China, France, Germany and USA, France, Germany (Table 2).

Table 2. The First Three Countries with the Highest Number of Organic Certified Cattle, Sheep, Pigs and Chickens in the World (Willer et al., 2014)

Species (million heads)	Countries		
Bovine	China (0.677)	USA (0.477)	France (0.440)
Sheep	Argentina (1.15)	England (0.89)	Italy (0.7)
Pig	China (0.215)	France (0.184)	Germany (0.144)
Poultry	USA (37)	France (11.6)	Germany (5.31)

2.2. Organic Animal Production in the EU

There has been a significant increase in the number of all organic certified farm animals raised in the EU between 2006 and 2019 (Table 3). However, the highest increase occurred in the number of poultry, followed by pigs, beehives, bovine, sheep and goats, respectively (Willer et al., 2021; Anonymous, 2021a).

Table 3. Change in the Number of Organic Certified Animals in the EU in the Period of 2006-2019 (Anonymous, 2021a)

Species	2006	2009	2012	2015	2019	Change (2006-2019) (%)
Bovine	1 744 538	2 204 676	3 250 557	3 636 091	4 817 726	+ 424 .5
Sheep	2 712 183	3 232 649	4 294 024	4 490 717	5 089 677	+ 230 .6
Goat	517 058	575 266	656 366	758 351	1 015 399	+ 201 .9
Pig	465 538	598 418	912 871	979 354	1 504 824	+ 495 .9
Poultry	11 368 575	12 864 077	26 010 830	33 753 615	48 685 483	+ 603 .4
Beehives	535 117*	889 913	1 064 057	776 175	784 024	+ 484 .2

* 2007 data

2.2.1. Organic sheep production in EU

According to 2019 data, there are 5 089 677 head of certified organic sheep in the EU (Table 3). The sheep production sector in the EU has mainly developed in Greece, and it is in the first place in terms of both the current sheep number and the increase rate of the sheep population in the last 5 years (Table 4). In addition, France, Austria and North Macedonia are among the countries that have increased the number of sheep in the last 5 years.

Table 4. Change in the Number of Organic Certified Sheep in EU Countries (head) (Top 10 countries) (Anonymous, 2021a)

Countries	2015	2016	2017	2018	2019	Change (2015-2019) (%)
Greece	609 617	593 999	935 267	1 299 677	1 229 684	+ 101.7
United Kingdom	874 196	841 110	889 538	826 598	782 253	- 10.5
France	457 638	513 276	602 124	1 132 809	737 091	+ 61.1
Italy	785 170	776 454	736 502	680 369	596 182	- 24.1
Spain	596 209	582 517	590 900	622 958	594 875	- 0.2
Germany	227 674	225 530	194 241	193 023	194 241	- 14.7
Austria	102 601	112 182	119 745	123 495	123 541	+ 20.4
Sweden	121 877	130 719	126 724	128 914	119 166	- 2.2
North Macedonia	70 170	81 621	94 825	101 317	110 669	+ 57.7
Portugal	108 375	85 551	99 328	96 620	94 117	- 13. 2

According to 2019 data, organic certified sheep milk production is 36 466 tons in the EU (Anonymous, 2021a). France has the largest share in this production with 30 276 tons (Table 5). This is followed by Spain (3 338 tons) and Bulgaria (1 679 tons), respectively. Although Greece has the highest number of certified organic sheep in the EU (Table 4), the amount of organic sheep milk production of this country is not available in Eurostat. This is probably because Greece did not report the relevant data to Eurostat and therefore is not shown in its database.

Table 5. Change in the Amounts of Organic Certified Sheep Milk Production in EU Countries (tons) (Top 10 countries) (Anonymous, 2021a)

Countries	2015	2016	2017	2018	2019	Change (2015-2019) (%)
France	15 891	16 580	20 493	25 956	30 276	+ 90.5
Spain	1 094	754	1 535	2 917	3 338	+ 205.1
Bulgaria	1 455	768	766	1 031	1 679	+ 15.4
Romania	:	1 102	:	:	462	- 58.1
Poland	58	107	79	88	165	+ 184.5
Cyprus	145	64	77	152	149	+ 2.8
Croatia	:	37	28	73	108	+ 191.9
Serbia	:	0	0	10	21	-
Lithuania	24	12	27	27	12	- 50.0
Czechia	62	66	54	21	10	- 83.9

: not available

According to 2019 data, organic certified sheep meat production is 20 238 tons in the EU (Anonymous 2021a). It can be said that the not available of Greece's sheep meat production data in Eurostat, as in its sheep milk production, is because the relevant statistics are not reported to the European Statistical Office, as explained in the above section. According to 2019 data in the EU, the country with the highest organic certified sheep meat production is Spain (9 490 tons), while the production amounts of other countries are at low levels (Table 6).

Table 6. Change in the Amounts of Organic Certified Sheep Meat Production in EU Countries (tons) (Top 10 countries) (Anonymous, 2021a)

Countries	2015	2016	2017	2018	2019	Change (2015-2019) (%)
Spain	8 344	7 873	7 103	8 569	9 490	+ 13.7
United Kingdom	7 600	7 300	7 900	7 600	4 900	- 35.5
France	1 132	1 276	1 432	1 684	1 861	+ 64.4
Sweden	1 131	1 138	1 109	1 187	1 063	- 6.0
Norway	602	622	712	641	563	- 6.5
Belgium	:	423	196	493	547	+ 29.3
Croatia	316	474	424	571	538	+ 70.3
Czechia	532	428	412	400	398	- 25.2
Finland	270	320	320	360	340	+ 25.9
Estonia	230	270	272	255	272	+ 18.3

: not available

2.2.2. Organic goat production in EU

Many dairy goat breeders who have traditionally produced in the EU in recent years have started to organic production mainly in order to gain a positive image and sell the milk they produce at higher prices. Actually, it is reported that the gain obtained from organic goat milk in Western Europe and Alpine regions is over 100% (Rahmann, 2009a, b; Lu et al., 2010). As can be seen from Table 3, the number of organic certified goats is approximately 1 015 399 heads in the EU in 2019. The country with the highest number of organic goats is Greece (498 219 heads) in EU, and this population constitutes about half of the EU's total organic goat population. Greece has followed by France (124 682 heads), Italy (99 418 heads), and Spain (79 966 heads) (Table 7).

Table 7. Change in the Number of Organic Certified Goat in EU Countries (head) (Top 10 countries) (Anonymous, 2021a)

Countries	2015	2016	2017	2018	2019	Change (2015-2019), (%)
Greece	344 479	326 255	375 514	494 031	498 219	+ 44.6
France	72 542	82 146	92 874	109 938	124 682	+ 71.9
Italy	100 852	113 983	115 590	110 055	99 418	- 1.4
Spain	69 448	73 400	71 741	76 506	79 966	+ 15.15
Netherlands	31 037	34 548	42 624	50 944	54 886	+ 76.8
Austria	40 686	45 879	48 017	51 099	51 751	+ 27.2
Switzerland	19 353	19 395	20 797	22 317	22 554	+ 16.5
Czechia	9 656	9 229	9 240	8 857	9 452	- 2.1
Romania	5 816	2 618	1 653	1 360	8 161	+ 40.3
Bulgaria	5 381	8 242	9 023	8 039	7 956	+47.9

According to 2019 data, organic certified goat milk production is 72 957 tons in the EU. The majority of this production was carried out by the Netherlands (36 320 tons), France (14 296 tons) and Spain (12 376 tons) (Anonymous, 2021a). Although Greece has the highest number of certified organic goat in the EU (Table 7), the amount of organic goat milk production of this country is not available in Eurostat. This is probably because Greece did not report the relevant data to Eurostat and therefore is not shown in its database.

Table 8. Change in the Amounts of Organic Certified Goat Milk Production in EU Countries (tons) (Top 10 countries) (Anonymous, 2021a)

Countries	2015	2016	2017	2018	2019	Change (2015-2019), (%)
Netherlands	20 261	19 485	24 614	33 421	36 320	+ 79.3
France	4 304	5 914	9 066	11 171	14 296	+ 232.2
Spain	9 988	9 227	8 270	11 251	12 376	+ 23.9
Belgium	:	3 053	3 600	3 869	3 776	+ 23.7
Romania	:	82	70	:	2 373	+ 2793.9
Cyprus	1 158	1 013	893	1 389	1 395	+ 20.5
Bulgaria	424	898	1 336	1 603	1 321	+ 211.6
Poland	661	595	637	668	543	- 17.9
Croatia	40	102	84	175	280	+ 600.0
Estonia	124	115	160	168	113	- 8.9

According to 2019 data, organic certified goat meat production is 534 tons in the EU (Anonymous, 2021a). The countries with the most developed organic certified goat meat production are Spain, Czechia, Croatia, Estonia and Norway, respectively.

Table 9. Change in the Amounts of Organic Certified Sheep Meat Production in EU Countries (tons) (Anonymous, 2021a)

Countries	2015	2016	2017	2018	2019	Change (2015-2019), (%)
Spain	520	411	311	491	482	- 7.3
Czechia	21	18	19	19	24	+ 14.3
Croatia	13	14	13	17	21	+ 61.5
Estonia	4	3	3	4	4	-
Norway	2	2	3	4	3	+ 50.0

2.3. Organic Animal Production in Turkey

In the last five years in Turkey, significant increases have occurred in the number of certified organic animals in all species except sheep and goats. The highest increases were observed in beehives, chicken and cattle, respectively (Table 10). However, the share of this sector in total animal production sector (< 1%) is very low (Anonymous, 2021b, c).

Table 10. Change in the Number of Organic Certified Farm Animals in Turkey (Anonymous, 2021b)

<table>
<tr><th>Years/Species</th><th>Cattle</th><th>Sheep</th><th>Goat</th><th>Chicken</th><th>Beehives</th></tr>
<tr><td>2016</td><td>6 971</td><td>17 334</td><td>7 022</td><td>857 642</td><td>40 371</td></tr>
<tr><td>2017</td><td>6 519</td><td>10 900</td><td>10 932</td><td>1 262 307</td><td>48 153</td></tr>
<tr><td>2018</td><td>5 113</td><td>10 475</td><td>10 685</td><td>1 242 170</td><td>51 742</td></tr>
<tr><td>2019</td><td>4 751</td><td colspan="2">16 711</td><td>844 319</td><td>50 100</td></tr>
<tr><td>2020</td><td>7 643</td><td colspan="2">2 204</td><td>1 091 423</td><td>70 385</td></tr>
<tr><td>Change (2016-2020), (%)</td><td>+ 9.6</td><td colspan="2">-</td><td>+ 27.3</td><td>+ 74.3</td></tr>
</table>

According to the 2020 data, 756 tons of meat, 21 800.6 tons of milk, 1 028.4 tons of honey and 182 991 927 eggs were produced as organic certified in Turkey. The highest-level contribution to organic certified total meat production is provided by organic beef while the highest-level contribution to organic certified total milk production is provided by cow (Table 11).

Table 11. Change in Production Amounts of Organic Certified Meat (tons), Milk (tons), Eggs (number) and Bee Products (tons) in Turkey (Anonymous, 2021b)

Product	Species	2016	2017	2018	2019	2020
Meat (tons)	Bovine	74.0	86.0	304.0	122.0	701.1
	Sheep	47.3	1.0	49.0	0.0	5.1
	Goat	1.6	0.0	15.0		
	Poultry	1 485.9	1 266.0	1 261.0	697.0	49.8
Total Organic Meat		1 608.8	1 353.0	1 629.0	819.0	756.0
Milk (Tons)	Cow	20 297.8	14 674.0	12 292.0	5 148.0	21 191.8
	Sheep	232.0	96.0	48.0	246.5	608.8
	Goat	901.0	339.0	543.0		
Total Organic Milk		21 230.9	15 109.0	12 883.0	5 394.5	21 800.6
Bee products (tons)		349.3	393.2	492.1	576.8	1 028.4
Egg (number)		147 600 367	161 254 080	174 675 362	179 781 501	182 991 927

The number of organic animal production certified producers is 495 in Turkey in 2020. Beekeeping was the production branch in which the farmers received the most organic certification. Although organic animal production is carried out in almost every region of Turkey, there are regional differences in terms of the type and intensity of production. It can be said that these differences in production are mainly due to the economic, cultural, sociological and environmental factors specific to the regions, as well as the differences in terms of knowledge and experience of traditional animal production (Dellal et al., 2015; Anonymous 2021b).

2.3.1. Organic sheep and goat production in Turkey

According to 2020 data, organic certified sheep and goat production is carried out in 2 regions in Turkey and the Marmara region ranks first in terms of the number of organic certified sheep and goats (Table 12).

When the last 5-year period given in Table 12 is examined, there has been no change in the number of provinces where production is made, while there have been significant decreases in the number of producers, the number of sheep and goats, and the amount of meat and milk produced from these species. However, the total number of organic certified sheep and goats does not reflect the amount of organic certified meat and milk produced. It can be said that this is due to the fact that most of the farmers do not have organic product certification.

Table 12. Changes In Number of Organic Certified Small Ruminant, Meat and Milk Production in Turkey by Region (Anonymous, 2021b)

Regions		**2016**	**2017**	**2018**	**2019**	**2020**
Marmara	Number of Provinces	1	1	1	1	3
	Number of Farmers	5	3	4	4	5
	Number of Animals (head)	3 644	1 291	3 075	2 824	2 109
	Meat (tons)	3.9	1.0	7.0	-	1.0
	Milk (tons)	1 024.0	355.0	524.0	246.5	608.8
Central Anatolia	Number of Provinces	1	1	1	1	-
	Number of Farmers	6	8	13	14	-
	Number of Animals (head)	15 139	19 290	16 951	13 153	-
	Meat (tons)	-	-	-	-	-
	Milk (tons)	-	-	-	-	-
Black Sea	Number of Provinces	1	-	-	-	1
	Number of Farmers	3	-	-	-	1
	Number of Animals (head)	4 513	-	-	-	95
	Meat (tons)	-	-	-	-	4.1
	Milk (tons)	-	-	-	-	-
Eastern Anatolia	Number of Provinces	1	1	1	1	-
	Number of Farmers	2	2	1	1	-
	Number of Animals (head)	1 060	1 251	1 134	734	-
	Meat (tons)	45.0	-	57.0	-	-
	Milk (tons)	109.0	80.0	67.0	-	-
Total	Number of Provinces	4	3	3	3	4
	Number of Farmers	16	13	18	19	6
	Number of Animals (head)	24 356	21 832	21 160	16 711	2 204
	Meat (tons)	48,9	1.0	64.0	0.0	5.1
	Milk (tons)	1 133.0	435.0	591.0	246.5	608.8

Organic certified small ruminant production in Turkey is mainly concentrated in the Marmara region and has been shown a sustainable trend, especially in Çanakkale. It can be said that the suitability of the production conditions of this province (especially Gökçeada) for organic goat production and the traditional Ezine cheese production have a stimulating effect. In Turkey, organic goat milk has been mainly used in the production of normal organic white and kashkaval cheese (Dellal et al., 2013).

3. CERTIFICATION OF ORGANIC SHEEP AND GOAT PRODUCTION

The word organic in organic agriculture is a labeling term and it confirms that the products are produced according to certain standards during production, transportation, processing and marketing and that these standards are certified by the certification institution and the state. Therefore, unlike traditional production systems, organic production systems are controlled by standards that must be followed by producers (Chander et al., 2011).

Certification of organic sheep and goat production and its products is included in organic agriculture certification. The most important state organic agriculture standards in the world are EU, NOP (USA-USDA-National Organic Program of the United States Department of Agriculture), JAS (Japanese Agricultural Standard) and Swiss (Bio Suisse) standards. IFOAM (International Federation of Organic Agriculture Movements) is the umbrella organization in terms of organic agriculture standards and accreditation program in the world. All standards can be put into practice in many countries of the world after they are approved within the framework of IFOAM (Schmid, 2013). Many countries in the world apply their own regulations in organic agriculture certification and the number of these countries is increasing. All organic products must be produced, labeled and sold according to these standards. A very important part of the standards used in the control of factors and practices such as transition periods, stock densities, aquaculture, feed materials and feeding, animal welfare, health and hygiene in organic sheep and goat production are the same and/or similar to other organic ruminant standards (Rahmann, 2009a,b; Lu et al., 2010).

The control of organic certified sheep and goat production in Turkey is carried out by the Ministry of Agriculture and Forestry in accordance with the "Organic Agriculture Law (No. 5262) and the Regulation on the principles of organic farming and their implementation. All kinds of control and certification processes of organic farming activities are carried out under the supervision of the control and certification institutions authorized by the Ministry and within the scope of the contract. The accreditation activities of these institutions are carried out by the Turkish Accreditation Agency (Anonymous, 2013).

4. THE FUTURE OF ORGANIC SHEEP AND GOAT PRODUCTION

It is reported that there are various opportunities that can positively affect the future of organic sheep and goat production in the world (Dellal et al., 2013; Dellal et al., 2015; Pehlivan et al., 2020). These are summarized below.

- Grazing of sheep and goats in organic marginal areas is a promising practice. In fact, it has been shown that the conventional production system in the marginal lands in the Andalusia region in Spain is behind the organic system in terms of feeding and sustainable pasture management, soil fertility and pollution, disease protection and treatment (Mena et al., 2008).
- The global acceptance of organic dairy products such as goat cheese is also an important opportunity for the growth of markets for organic sheep and goat meat and fiber products.
- There are opportunities to convert traditional sheep and goat production systems into organic production systems more easily and effectively in mountainous and forested areas.
- The positive contribution of organic sheep and goat production on environmental protection, human health, animal welfare and the maintenance of rural life will also accelerate its own development.
- Progress in the prevention and treatment of animal diseases, depending on traditional and alternative health practices, also

gives hope for the development of organic sheep and goat production.

- It will also have a positive impact on the future of organic sheep and goat production by developing alternative practices that are environmentally friendly, caring for human health and sensitive to animal welfare and conveying their effects to consumers.

It is expected to developing organic sheep and goat production in the future due to many positive factors in Turkey as well as world. These factors are listed below.

- Traditional goat production is carried out most intensely in the Mediterranean, Aegean and Southern Anatolia regions of Turkey. The production in these regions, generally in mountainous areas, is an important source for organic goat production and the transition to the organic production system will be easier.
- One of the most important inputs of organic sheep and goat production is pastures capacity. The fact that there are pastures of sufficient width and quality in Turkey, especially in the Eastern and Southern Anatolia Regions, is an opportunity for the development of organic sheep and goat production in these regions.
- It can be said that the traditional and cultural importance of sheep and goat breeding in Turkey and the wider use of traditional sheep and goat milk, meat and fiber products are also an important opportunity for the development of organic sheep and goat production.

- The fact that there are many islands in Turkey can be seen as an opportunity for the development of organic sheep and goat breeding.
- Turkey has 27 native sheep and 6 native goat breeds (Ceyhan et al., 2015). Since native breeds and types are more resistant to stress and diseases, antibiotics will be needed much less in organic production with these breeds.

Along with the opportunities mentioned above, the current structural, technical, socio-cultural and economic characteristics and consumer trends of organic sheep and goat breeding in Turkey should be determined and the future of organic sheep and goat breeding should be planned based on these data.

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CHAPTER 6

ORGANIC EGG PRODUCTION

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INTRODUCTION

In the world, organic (ecologic, biologic) production is progressively increasing in popularity. Production volume, number of farmers, consumer demand and market volume display a steady increase.

Organic production system includes health criteria in product quality besides product yield. At the same time, the organic poultry production system makes a positive contribution to rural development.

Today, the organic egg production system has certain production standards. Organic egg system is a rearing system in which conventional feedstuffs, animal by-products, synthetic additives and genetically modified organisms are not used. Layers are fed with organic plant materials such as cereals grain, expeller oilseed meals, roughages and other ingredients. Layers have free access to outdoor areas and cannot be raised in cages.

Due to the increasing sensitivity of people to a healthy and balanced diet, many people prefer to consume organic eggs. Today, the negative evaluation of synthetic feed additives by consumers is increasing. For this reason, natural additives have been preferred in recent years to improve egg quality without leaving any residue in the product or in the environment.

It is expected that organic egg production will develop in line with the demand of consumers in the future. This is due to consumer perceptions that organically produced eggs are healthier, that layer are raised in a more humane behavior, and that organic egg growing is better for natural resources and environment. However, the costs of organic egg production versus conventional production are higher due to slower growth and lower feed efficiency.

Organic egg production model is applied according to the standards arranged by international and national regulations of countries. Also, layers are fed permitted organic feeds and feed additives. In addition, organic egg production takes environmental protection and animal welfare into account. In this process, requires maintenance of basic animal welfare standards.

Numerous management and environmental factors affect organic egg production such as breeds, housing and outdoors (intensity, light exposure), nutrition (quality-quantity feed and feed additives, water intake) and animal health (parasite infestation, disease).

The aim of this part is to give information about the use of organic egg production and composition of organic eggs.

1. BREEDS AND REARING OF STOCK

Organic producers should select breeds that are suitable to the site, well-adapted to the climate, and resistant to diseases and parasites that are common in the area. Furthermore, in the selection of breeds, those that can adapt to the climatic conditions of the region where organic production will be made should be selected. The performance of poultry breeds varies according to different conditions. Poultry breeds vary with respect to the range of temperature in which they grow and maintain good productivity. Some breeds perform better in colder climates and some in warmer climates and some adapted to pasture easily. Producers should consider their needs and hatchery breed guide for breed selection can help.

Producers can choose true or hybrid breed or native hens for organic egg production. The selection of breeds should be determined by taking into the account of production conditions. It is recommended to prefer native breeds and strains.

Rizzi, (2020) found higher laying rate, hen-day edible egg mass and double-yolk egg, and a lower body weight in Hy-Line Brown (HB) and Hy-Line White 36 (HW) than Ermellinata di Rovigo (ER) and Robusta maculata (RM) in organic conditions. Egg scoring was found to be higher in HW than HB and RM and ER was intermediate. The most defective eggs were found in RM and the least in HB.

There are many different true or hybrid breeds of white or brown egg layers and each has advantages and disadvantages for egg production such as Ameraucana, Ancona, Australorp, Babcock, Barnevelder, Barred Rock, Brahma, Bovans Browns, Bovans Gold, Bovans Nera, Buckeye, Buff Orpington, Chantecler, Dekalb Brown, Dekalb White, Delaware, Dominique, Easter Eggers, Euskal Oiloa, Faverolles, Golden laced wyandottes, Jersey Giant, Hamburg, Hisex, Hylines, Isa Brown, Leghorns, Lohmann LSL, Marans, Minorca, New Hampshire red, Orpington, Plymouth Rock, Red sex link, Red Star, Rhode Island Reds, Sex Link, Shaver, Spanish (White-Faced Black Spanish), Sussex, Warren, Wyandotte, Welsummer and many native laying hens.

If eggs are to be sold as an organic product, poultry for egg production must be raised for at least six weeks according to the organic rules. If non-organic animals are to be used when creating a flock first time, pullets should not be older than 18 weeks.

2. HOUSING

The poultry housing should be designed to allow natural behaviors and opportunity to exercise, appropriate temperature levels and ventilation and the potential for layers injury to be reduced. It should not cause damage to their well-being e.g. foot injuries, keel bone damage, feather pecking and cannibalistic pecking.

Organic layer producers provide indoor and outdoor, shade, the area where the animal can do its natural behavior and clean water for all layers, appropriate for their life stage, climate and environment. The poultry house conditions should not adversely affect the well-being of the laying hen.

The housing and husbandry conditions for laying hens reported in the European Commission Regulation (EC) No 889/2008 are given below.

- Houses for organic laying hens shall have the appropriate size and number of perches. It should also have sufficient floor area for the collection of droppings,

- Maximum 3000 layer hens shall rear in each house,
- Maximum number of laying hens equivalent to the amount of manure (per ha equivalent to 170 kg N/ha/year) that can be stocked in the enterprise is 230,
- Layers shall have access to an open air area for at least one third of their life,
- Houses should be planned to allow all birds easy access to the outdoors and it shall have adequately sized exit/entrance holes (at least 4 m per 100 m^2 area of the house),
- Vegetation is preferred in the outside area. There should be equipment in the outdoor area to protect the animal from adverse weather conditions. In addition, there should be a sufficient number of feeders and drinkers, and the animals should be able to easily consume feed and water,
- An adequate amount of roughage and suitable material should be provided for animals that cannot access the outside area due to necessity,
- Layer hens should be provided with an eight-hour nocturnal rest period in the dark. They should be exposed to natural or artificial light for up to sixteen hours a day,
- Layers shall not be kept in cages,
- Housing, equipment and all materials used shall be properly cleaned and disinfected. Feces, urine and uneaten or spilled feed should be removed as soon as possible,
- Houses shall be cleaned and disinfected with potassum and sodium soap, water and steam, milk of lime, lime, quicklime, sodium

hypochlorite (e.g. as liquid bleach), caustic soda, caustic potash, hydrogen peroxide, natural essences of plants, citric, peracetic acid, formic, lactic, oxalic and acetic acid, alcohol, formaldehyde and sodium carbonate when emptied between each batch of hens, and houses shall be left empty to allow vegetation to regrow.

Organic Agriculture Regulation (European Union Commission Regulation EC No 889/2008) recommendation advises the following minimum space requirements are presented in Table 1.

Table 1. Minimum Surface Areas and Housing Features for Layer Hens

Indoors area (net area available to animals)			Outdoors area (m^2 of area available in rotation/head)
Animals/m^2	cm perch/animal	Nest	
6	18	7 laying hens per nest or in case of common nest 120 cm^2/bird	4, provided that the limit of 170 kg of N/ha/year is not exceeded

3. PACKAGING, TRANSPORT AND STORAGE

- Organic feed, in-conversion feed, and non-organic feed should be separated during processing, packaging, transport and storage.
- Organic eggs shall be collected separately from non-organic eggs.
- If producers have to collect organic and non-organic products simultaneously, they can collect organic and non-organic products together, provided that they get permission from the authority. In this case, appropriate measures should be taken to prevent possible mixture.
- Producers should record information about the delivery of products.

4. ANIMAL HEALTH

Animal-health management in egg production should be based on disease prevention. First of all, a healthy environment with good sanitation, biosecurity measures and minimize stress are necessary for preventive health.

Vaccination (Newcastle and Marek's disease and infectious bronchitis) is against prevalent diseases of poultry is allowed in organic production, as long as the vaccines are not genetically modified. Further, healthy living conditions, adequate ventilation, clean feeding and watering systems are very important reducing diseases such as coccidiosis.

5. NUTRITION AND FEEDING

Optimal feeding strategies must be applied in order to fully meet the increasing metabolism and increasing nutrient requirements during the laying hens' production periods. Undoubtedly, adequate and balanced nutrition of high-performance laying hens can be met by creating the right feed formulations that are compatible with energy, protein, vitamin and trace mineral requirements.

European Union Organic Agriculture Regulation (889/2008) lists the feeds that are allowed or not allowed to be fed in organic egg production and the transition period of organic feeds are defines. The producers can have organic layer rearing only if they produce their own feed according to organic rules or by purchasing organic certified feeds. Only organic raw materials may be used. The use of synthetic substances are not allowed such as solvent extracted meals, synthetic feed additives, aminoacids, growth promoters and antioxidants etc.

These regulations must also be met with regard to feed safety. Feeds should be analyzed periodically for nutrients and mycotoxins (Blair, 2008). Schiavone et al. (2008) determined that ochratoxin A in both conventional and organic feeds (0.04 to 6.50 μg kg-1). Moreover, the use of ionising radiation for raw materials and organic feeds are prohibited. Also, hormones and hormone derivatives cannot be used.

Today, the production of organic protein sources are insufficient to meet the nutritional requirements of organic poultry farmers. Therefore can be used alternative protein sources (legumes, insect flour, algae etc.).

It is recommended to add roughage, fresh or dried fodder, or silage to diets. Force-feeding is forbidden. Also, animals should be able to intake clean water *ad-libitum*.

Classes of feed materials can be used in organic layer diets given Table 2 and feed additives can be used in organic layer diets given Table 3.

Daily feed intake of layers is relatively low between the onset of egg production and peak egg production (approximately 32 weeks of age). Nevertheless, nutrient requirements increase during this critical stage because bird continuous to growth, and the size and production of egg rises. Therefore, the first layer diet should be fairly concentrated. The nutrient requirements of laying hens depend on the daily egg mass in post peaking period. The best way of ensuring proper nutrition is the use of a phase feeding system matched to the changes in nutrient requirements (Leeson & Summers, 1997).

Layer diets have higher calcium contents than per-lay diet since egg weight and production increase for peaking period and the hens' ability to absorb calcium from the diet diminishes for post peaking period. The eggshell contains about 2.2 g calcium. Adequate dietary levels of calcium should be provided in order to ensure proper calcification of the eggshell. The source and particle size of calcium used in laying hens diets are also of importance. Coarse limestone or oyster shell should be added to the laying hen's diet to meet the calcium needed for egg shell formation (Altan, 2015).

Table 2. Classes of Feed Materials Used Organic Layer Diets

Class	**Characteristics**
Organic feed materials of plant origin	Energy-rich feed sources: maize, wheat, barley, triticale, sorghum, oats, rye, buckwheat, wheat bran, maize gluten meal, cassava, potatoes, molasses, bakery waste, citrus pulp, distillers and brewers by-products, fats and oils etc. Protein-rich feed sources: beans, peas, lupins, expeller soybean, cottonseed, rapeseed, canola, linseed, peanut, safflower and sunflower meals, single-cell protein etc. Roughages: pasture, range plants, and forages fed green, cultivated fodder crops, grasses legumes, tree leaves, and silage/haylage (wet roughages), hays, straws, hulls and crop residues as seed coats, pods, bran (dry roughages) etc.
Feed materials of animal origin	Milk and milk products: raw milk, milk powder, skimmed milk, skimmed-milk powder, buttermilk, buttermilk powder, whey, whey powder, whey powder low in sugar, whey protein powder (extracted by physical treatment), casein powder, lactose powder, curd and sour milk Fish, other marine animals, their products and by-products (products origin only from sustainable): fish, fish oil and cod-liver oil not refined, fish molluscan or crustacean autolysates, hydrolysate and proteolysates obtained by an enzyme action, whether or not in soluble form, solely provided to aquaculture animals and young livestock, fish meal, crustacean meal Egg and egg products: eggs and egg products for use as poultry feed, primarily from the same holding
Feed materials of mineral origin	Sodium: unrefined sea salt, coarse rock salt, sodium sulphate, sodium carbonate, sodium bicarbonate, sodium chloride Potassium: potassium chloride Calcium: lithotamnion and maerl, shells of aquatic animals (including cuttlefish bones), calcium carbonate, calcium lactate, calcium gluconate Phosphorus: defluorinated dicalcium, phosphate, defluorinated monocalcium phosphate, monosodium phosphate, calcium-magnesium phosphate, calcium-sodium phosphate Magnesium: magnesium oxide (anhydrous magnesia), magnesium sulphate, magnesium chloride, magnesium carbonate, magnesium phosphate Sulphur: sodium sulphate

Table 3. Feed Additives Added to Organic Layer Diets

Categories	Feed additives
1. Technological additives	a. Preservatives: sorbic acid, formic acid, acetic acid, lactic acid, propionic acid, citric acid b. Antioxidants: Tocopherol-rich extracts of natural origin used as an antioxidant, natural antioxidant substances c. Binders and anti-caking agents: calcium stearate of natural origin, colloidal silica, kieselgur, bentonite, kaolinitic clays, natural mixtures of stearites and chlorite, vermiculite, sepiolite, perlite
2. Sensory additives	aromatic compounds (extracts from agricultural products only)
3. Nutritional additives	a. Vitamins, provitamins and chemically well defined substances having a similar effects: vitamins derived from raw materials occurring naturally in feedingstuffs and synthetic vitamins identical to natural vitamins b. Compounds of trace elements (iron: ferrous (II) carbonate ferrous (II) sulphate monohydrate and/or heptahydrate ferric (III) oxide; iodine: calcium iodate, anhydrous calcium iodate, hexahydrate sodium iodide; cobalt: cobaltous (II) sulphate monohydrate and/or heptahydrate basic cobaltous (II) carbonate, monohydrate; copper: copper (II) oxide basic copper (II) carbonate, monohydrate copper (II) sulphate, pentahydrate; manganese: manganous (II) carbonate manganous oxide and manganic oxide manganous (II) sulfate, mono-and/or tetrahydrate; zinc: zinc carbonate, zinc oxide, zinc sulphate, mono-and/or heptahydrate; molybdenum: ammonium molybdate, sodium molybdate; selenium: sodium selenate sodium selenite)
4. Zootechnical additives	a. Enzymes: dry and/or liquid form beta-glucanase, beta-xylanase, endo-beta-xylanase, alpha-amylase, alpha-galactosidase, alpha-amylase, phytase b. Microorganisms: yeasts (Saccharomyces cerevisiae, Saccharomyces carlsbergiensis)

Estimated nutrient requirements of Leghorn-type laying hens given Table 4, estimates of ME (kcal) required per laying hen per day in relation to body weight and rate of egg production given Table 5, nutrients and rations for organic layer production given Table 6, 7 and 8.

Table 4. Estimated Nutrient Requirements of Leghorn-type Laying Hens, Amounts per day[a] (NRC, 1994)

	Amounts per day	
	White-egg layers	Brown-egg layers
Feed intake (g/day)	100	110
Crude protein (g)	15.0	16.5
Amino acids (g)		
Arginine	0.7	0.77
Histidine	0.17	0.19
Isoleucine	0.65	0.72
Leucine	0.82	0.9
Lysine	0.69	0.76
Methionine	0.3	0.33
Methionine + cystine	0.58	0.65
Phenyalanine	0.47	0.52
Phenyalanine + tyrosine	0.83	0.91
Threonine	0.47	0.52
Tryptophan	0.16	0.18
Valine	0.7	0.77
Minerals (g)		
Calcium	3.25	3.6
Phosphorus (non-phytate)	0.25	0.28
Chloride	0.13	0.15
Magnesium	0.05	0.06
Potassium	0.15	0.17
Sodium	0.15	0.17
Trace minerals (mg)		
Copper	ND	ND
Iodine	0.004	0.004
Iron	4.5	5.0
Manganese	2.0	2.2
Selenium	0.006	0.006
Zinc	3.5	3.9
Vitamins		
Vitamin A (IU)	300	330
Vitamin D3 (IU)	30	33
Vitamin E (IU)	0.5	0.55
Biotin (mg)	0.01	0.011
Choline (mg)	105	115
Folacin (mg)	0.025	0.028
Niacin (mg)	1.0	1.1
Pantothenic acid (mg)	0.2	0.22
Pyridoxine (mg)	0.25	0.28
Riboflavin (mg)	0.25	0.28
Thiamin (mg)	0.07	0.08
Vitamin K (mg)	0.05	0.06
Cobalamin (vitamin B12) (μg)	0.4	0.4
Linoleic acid (g)	1.0	1.1

[a]Based on a maize/soy diet. Some values were stated as being tentative, ND = not determined

Table 5. Estimates of ME (kcal) Required per Laying Hen per day in Relation to Body Weight and Rate of Egg Production (NRC, 1994)

Body weight (kg)	Rate of egg production (%)					
	0	50	60	70	80	90
1.0	130	192	205	217	229	242
1.5	177	239	251	264	276	289
2.0	218	280	292	305	317	330
2.5	259	321	333	346	358	371
3.0	296	358	370	383	395	408

Table 6. Example Nutrient Contents and Rations for Organic Layer Production in UK-layer high protein (Lampkin, 1997)

Ingredients (%)	Least cost organic ration formulations (own calculations)	
	UKROFS	EU prop.
Cereals	4.0	37.8
Wheatfeed	46.0	13.1
Brewers/distillers grains	5.4	0.6
Maize/maize germ meal	0.0	0.0
Maize gluten (60%)	0.0	0.0
Peas/beans	15.0	15.0
Soyabeans	0.0	9.1
Oilseeds	0.0	0.0
Dried grass/luceme	5.0	5.0
Dairy by-products	0.0	0.0
Fishmeal	3.0	0.0
Vegetable o il	7.4	1.4
Molasses	0.0	0.0
Yeast	3.1	5.0
Calcium/phosphate sources	8.4	9.5
Salt	2.5	3.1
Mineral/vitamin supplement	0.2	0.3
Nutritional value (%)		
Crude protein	18.0	18.0
Metabolisable energy (MJ/kg)	11.0	11.0
Methionine	0.3	0.3
Lysine	0.9	1.0
Linoleic acid	4.9	1.8
Calcium	3.5	3.5
Available phosphorus	0.5	0.5
Raw material cost (£/t)*	199	242

UKROFS, United Kingdom (UK) Register of Organic Food Standards performance quantity (g) 130 per day, period 19-44 weeks
*add £20-25 for processing and £12-15 for bags

Table 7. Example Nutrient Contents and Rations for Organic Layer Production in UK-layer medium protein (Lampkin, 1997)

Ingredients (%)	Least cost organic ration formulations (own calculations)		
	UKROFS	EU incl. amino acid	EU excl. amino acid
Cereals	20.2	30.3	23.7
Wheatfeed	30.0	29.7	30.0
Brewers/distillers grains	6.3	0.6	0.0
Maize/maize germ meal	0.0	0.0	0.0
Maize gluten (60%)	0.0	0.0	0.0
Peas/beans	14.8	15.0	15.0
Soyabeans	0.0	0.0	6.3
Oilseeds	0.0	0.0	0.0
Dried grass/luceme	5.0	5.0	5.0
Dairy by-products	0.0	0.0	0.0
Fishmeal	0.0	0.0	0.0
Vegetable o il	7.7	3.4	3.6
Molasses	0.0	0.0	0.0
Yeast	3.6	5.0	4.5
Calcium/phosphate sources	9.2	8.2	8.7
Salt	2.9	2.5	2.9
Mineral/vitamin supplement	0.3	0.2	0.2
Amino acids	0.1	0.1	0.0
Nutritional value (%)			
Crude protein	16.0	16.0	17.0
Metabolisable energy (MJ/kg)	11.0	11.0	11.0
Methionine	03	0.3	03
Lysine	0.8	0.8	1.0
Linoleic acid	4.9	2.7	3.1
Calcium	3.5	3.5	3.5
Available phosphorus	0.5	0.5	0.5
Raw material cost (£/t)*	198	224	235

UKROFS, United Kingdom (UK) Register of Organic Food Standards
performance quantity (g) 130 per day, period 45-72 weeks
*****add £20-25 for processing and £12-15 for bags

Table 8. Example Diets for Organic Layer Feding, kg/tonne (Bennett, 2013)

Ingredient	Layer Diet, 16% Protein	Layer Diet, 14% Protein
Wheat	474	561
Peas	333	327
Roasted full-fat soybean	77	0
Limestone	92	92
Dicalcium phosphate	14.29	10.83
Salt	3.07	2.68
DL Methionine	1.60	1.47
Vitamin-Mineral Premix[1]	5.00	5.00
Total	1000	1000

[1]The vitamin-mineral premix should be added according to the manufacturer's recommendations.

6. NUTRITIVE CHARACTERISTICS AND CONTAMINANTS IN ORGANIC EGGS

Eggs, which have been consumed by humans since ancient times, are an excellent natural food source. Egg is defined as the most useful food after breast milk. The biologic value of the egg proteins and their amino acids are unique, so it is used as a reference in the evaluation of other protein sources.

The egg consists of 9-11% shell, 60-63% albumin and 28-29% egg yolk. The main components of the shellless egg are water (75.8%), protein (12.9%) and lipids (9.9%) (Altan, 2015). Egg contain significant levels of unsaturated fatty acids (especially oleic acid), iron, phosphorus, trace elements, B vitamins including vitamins A, E, K, B_{12} and natural vitamin D (second only to fish liver oil). Except for the shell, the calcium content is very low and there is little or no vitamin C (Cook & Briggs, 1986). It contains small amounts of carbohydrates and some important bioactive components. Although egg is a protein source rich in easily digestible fat and essential amino acids, its energy content (148 kcal/100 g) is quite low (Altan, 2015).

Many factors affect the chemical composition and nutritional properties of the egg such as chicken age, genotype, feeding, environmental conditions (lighting, temperature, etc.) and storage conditions. It has been reported that the housing system can affect the chemical composition of chicken eggs (Matt et al., 2009) Today, alternative laying hen production systems have gained importance for egg production.

Moisture was the higher in conventional egg yolks and albumen than organic eggs while protein was higher in organic egg yolks and albumen than conventional eggs. Also, organic eggs contained higher amounts of n-3 fatty acids than conventional ones (Filipiak-Florkiewicz et al., 2017).

On the other hand, Minelli et al. (2007) obtained that weight of egg, yolk, albumen, eggshell and eggshell breaking strength of organic eggs lower than conventional eggs. Organic eggs showed higher contents of protein (17.1% vs 16.7%) and cholesterol (1.26% *vs* 1.21%). The organic yolks were paler than the conventional ones.

Mizumoto et al. (2008) and Hidalgo et al. (2008) reported no difference in protein contents of eggs from hens reared in organic or conventional husbandry systems.

The cholesterol level and fatty acid composition of eggs are important in terms of their effects on human health. The research comparing the total lipid amounts of organic eggs and conventional eggs is insufficient. Hidalgo et al. (2008) and Samman et al. (2009) found no differences between organic eggs and conventional eggs for total lipid concentration. In another study**,** Mizumoto et al. (2008) found that total lipid concentration of organic eggs was decreased.

Stanley et al. (2013) reported that hen-day egg production in the cage system was higher than floor system. There were no difference between egg weight, albumen, yolk or shell weights. More marketable eggs produced in the cage system than floor system. Egg shell bacteria counts lower at 0 and 4 h after laying than floor system while there was no significant difference in contamination of eggs collected 8 h after laying.

In another study, Gram-positive bacteria consistent tendency from organic layer flocks are more susceptible to antimicrobials than conventional layer flocks. According to these results, organic production will contribute to the reduction of antibiotic resistance (Schwaiger et al. 2010).

Küçükyılmaz et al. (2012) observed that P and Zn contents of organic eggs were lower than conventional eggs but ash, Ca, Mg, Fe and Cu contents did not differ. While organic and conventional eggshell had similar ash, Ca, P, Fe and Cu content, Mg was determined higher in organic eggshell than conventional eggshell.

Arslanbaş & Baydan (2013) determined that while Cd, Pb and Cu contents lower than the limit values both organic and conventional eggs, Fe content was higher in organic eggs than conventional.

In the study by Kamal et al. (2016) determined the Cd and Pb contents of organic eggs have exceeded the permissible maximum amounts in Egypt.

Since the use of veterinary drugs in organic egg production is prohibited, veterinary drug residues are generally not found in organic eggs. Hoogenboom et al. (2008) did not determined toltrazuril and aminoglycosides, sulfonamides, beta-lactam, tetracyclines, quinolones, and colistin in organic eggs. Also, cadmium, lead, arsenic and mercury contents are also lower than the limits.

7. CONCLUSION

The organic production system, which aims at a closed nutrient cycle depending on the principles of sustainable organic production, has gained importance today. Organic egg production and consumption should be increased owing to the fact that egg is valuable food sources.

It is recommended that development of different housing systems, evaluation of organic feeds, analysis of chemical properties and contaminants, development of on-farm diets and investigating the nutritional contribution of pasture are important. In addition, it is important to increase organic feed production and to investigation to alternative organic feed materials. Moreover, the nutritional value and contaminants of the organic egg should be revealed due to its in the organic consumers diet frequently.

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CHAPTER 7

ORGANIC BROILER FARMING

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INTRODUCTION

The advancements in the sector of organic poultry farming in Turkey are affected by developments in the World. It is observed that new enterprises are established to meet the increasing demand in the World and Turkey.

To reduce feed costs in organic production, it is very important to create an appropriate pasture composition by utilizing local plants and provide a certain part of the nutrient needs from the pasture. Furthermore, the impacts of environmental conditions and housing techniques on the health of the product to be obtained and living beings are known. It is necessary to pay attention to the application of housing techniques that will not compromise organic production standards and are compatible with local conditions.

The grazing-resistant pasture composition, which animals fondly consume, will contribute to meeting their daily nutritional needs and making production economical. Housing systems and the materials that will be used in these systems must also comply with organic production standards. Local climatic conditions should be taken into account when organizing the feeders and drinkers to be placed in the pasture and poultry house, and it should be ensured that heating tools in the poultry house do not emit light in a way that will disrupt the lighting program. The cover materials that will eliminate the fear and temperature concerns of animals should be used in the grazing area, and the cover material to be selected should be of a quality to prevent the entry of wild birds and predators. The primary issue in the selection of equipment should be organic standards, and the selected equipment and practices should also help improve product quality.

Conventional, organic, and free-range production systems are applied both in egg production and broiler production. Free-range production systems, whose philosophy is based on legal animal rights, have been developed and transformed into an organic production model to meet the demand for natural products, gaining an increasing economic sales potential and increasing demand worldwide.

In many countries of the World, in the European Union (EU) and the United States (US), a number of standards, which are also accepted by Turkey, have been developed to control organic production and to prevent unfair competition. Animal welfare constitutes the source of the developed standards and includes areas such as housing, feeding, and health.

In the poultry farming sector, which has been industrialized in the conventional production system, issues such as health protection, feed material, genotype, and equipment have also developed in a way to support conventional production. Therefore, some difficulties and cost-increasing system requirements are encountered in the development of genotype, feed, health protection, and equipment in line with organic production standards. Numerous research and development studies are ongoing to eliminate the problems encountered. Among these, research on genotype development suitable for organic production that will also ensure economic efficiency and the search for benefiting from local gene resources attract attention. Different results are obtained in studies that will not prevent and will improve animal welfare in lighting, heating, flock health, free-range and feeding practices, which are among the housing techniques in organic production.

The genotype used, climate and marketing techniques, regional differences, and the direction of production constitute the source of these differences. Feed cost constitutes a large part of the inputs in organic poultry farming. To ensure economic organic production, the level of pasture use efficiency should be taken into account, the suitability of the plant pattern to be used in chicken pastures that will be created should not be ignored, and studies in this direction should be carried out. The condition stating that all of the raw materials to be included in the composition of the compound feed to be used in feeding must be certified organic causes some difficulties in balancing the ration in terms of nutritional value. The main problem is that the organic raw material to be used in balancing the ration is not available enough and economical.

Supporting studies on the development of local genotype resources for use in organic production, which will allow the use of local feed resources, will help overcome such problems. The basis of the increasing demand for organic production is that both feed and health practices at every stage of production do not create residues that may affect human health. Hence, there is a need for research on developing health protection measures and using natural methods for treatment.

In this section, health protection and treatment methods, and breeding and feeding techniques used in organic broiler production will be discussed, and suggestions to overcome the difficulties encountered will be given.

1. HOUSING AND HOUSING CONDITIONS

As in all production systems of poultry farming, shelters complying with production direction and standards should also be planned in organic broiler farming. The most important parameter is the appropriate stocking density to ensure animal welfare. It is necessary to provide a barn area to ensure adequate freedom of movement as well as a free-range area to meet the need for freedom of behavior. Free-range increases animal welfare (Zeltner & Maurer, 2009; Ruis et al., 2004). Attention should be paid to not exceeding the nitrogen limit of 170 kg per hectare annually for the pastures, open shelters, and free-range areas to be used (Öztürk et al., 2013).

The impact of chickens' feeling safe on their behavior of using the open area is significant (Zeltner & Maurer, 2009). On the other hand, as the flock size increases, the rate of animals' open area uses decreases (Hirt et al., 2000).

Free-range of 75% of chickens in the area close to the house (Fürmetz et al., 2005) leads to excessive damage to the vegetation around the house (Menzi et al., 1997). Consequently, the amount of nitrogen in the soil increases (Elbe et al., 2005).

Many studies are conducted on the use of entire grazing area (Eleroğlu et al., 2014). It is reported that shades, trees, and fences inside the free-range area influence the use of the pasture (Zeltner & Maurer, 2009; Nicol et al., 2003; Zeltner & Hirt, 2003), and weather conditions have a more significant effect on chickens' visit to the grazing area than the pasture structure (Hegelund et al., 2002). In line with these studies, a study was conducted at Cumhuriyet University to ensure the homogeneous use of the grazing area. In this study, portable poultry houses, designed with shaded sections below, were used, and the pastureland was covered with a plastic net to prevent contact with wild birds and create a semi-shade in the grazing area. The area around the research site was protected by wire fences against predators (Image 1).

Image 1. Organic poultry farming research site at Sivas Cumhuriyet University

All of the building materials used in the houses were selected in accordance with organic standards. Portable poultry houses are planned as two floors, consisting of a shelter 50 cm high from the ground and a shelter with feeders, drinkers, perches, and laying nests appropriate for organic standards (Image 2). Ventilation, paths of entering and exiting the pasture were planned to keep animal welfare at the highest level, and ceramic electric heaters not providing lighting were used (Eleroğlu et al., 2014).

Image 2. Suitable shelter for organic poultry farming

The condition of feathering is also accepted as an indicator of welfare (Winckler et al., 2004), and housing techniques affect animal behavior. For example, it has been reported that feather-pecking behavior may change depending on the frequency of open space use (Nicol et al., 2003; Bestman & Wagenaar, 2003). Although feather-pecking behavior is reduced in chickens using open space, feather-pecking continues to be a problem due to the prohibition of beak-trimming in organic production (Eleroğlu et al., 2014). For example, in the Netherlands, the feather-pecking rate was calculated as 70% in organic laying houses, and the same value was calculated as 54% in organic rearing houses (Bestman & Wagenaar, 2006).

Practices that will increase animal welfare during the rearing period will also influence the production period. Negative practices such as unbalanced feeding, insufficient drinker spacing, unhealthy litter management, and high stocking density during the rearing period cause feather-pecking and similar negative behaviors (Bestman & Wagenaar, 2006; Knierim et al., 2008).

In organic broiler farming, the space requirement should be calculated as 10 chicks/m^2 (maximum 21 kg live weight/m^2) in barns. Houses should be planned to allow animals to display their natural behavior. Access to feed and water should be easy, and equipment should be used in quantity and quality that will not cause competition. Natural ventilation and light should be allowed in houses, and precautions should be taken pests such as mice and birds cannot enter them from the outside.

At least 1/3 of the floor should be covered with materials such as straw-hay, sawdust, sand, or short grass. Houses should have entry/exit holes, and these holes should be at least 4 m long for every 100 m^2 of the poultry house. The capacity of each house should be planned not to exceed 4800 broilers. Broilers are reared under free conditions and cannot be housed in cages. Poultry houses and free-range areas are left empty between two production periods, during which buildings and equipment are cleaned and disinfected with permitted substances.

Chick feeder

Chick drinker

Hanging poult feeder

Hanging poult drinker

Nipple drinker system

Automatic feeding system

There should be a sufficient number of feeders and drinkers suitable for organic standards in the barn and free-range area. There should be one feeder for 25 chickens in hanging feeders, and a 10 cm feeder length per chicken should be calculated in automatic feeding systems. There should be one drinker for 50 chickens in hanging drinkers, and a sufficient length and number of nipples should be calculated in the nipple drinker system. During the chick-rearing period, one chick drinker and two chick feeders are calculated for 50 chicks.

Attention should be paid to ensure that the litter material is dust-free and does not allow dusting. Litter materials with high water absorption capacity suitable for regional characteristics and which will not harm chickens can be used. The litter should have an average weight of 5-6 kg/m^2 and a height of 5-6 cm. Attention should be paid to using dry litter, and it should be changed in case of excessive wetness.

Twenty-four hours before chicks arrive in the poultry house, the temperature inside the house should be heated to 32-33 °C at the chick level, lowered by 1 °C every 3 days and kept constant at 20-22 °C after the 21st day. The relative humidity in the house should be between 60-70%. Initially, the house can be divided with a suitable material to reduce heating costs and achieve homogeneous heating. Homogeneous heating can be achieved by surrounding the chicks up to two weeks of age with a material 3-3.5 m in diameter and 30-35 cm in height in a circular manner for each 600-800 chicks.

It is possible to carry out 3-4 periods/year of breeding in the same poultry house. Necessary cleaning and disinfection should be performed by taking a break of 10-15 days between the two production periods. Protection from diseases can be ensured in this way. The used equipment should be placed after disinfection in houses washed with pressurized water. Attention should be paid to the transfer of chicks from the hatchery to the house, and they should be transferred in the shortest time possible and with their needs met.

After the transfer, the chicks placed in the house are provided with access to clean drinking water and feed. At the end of the first three days, chick drinkers should be removed, and hanging drinkers or nipple drinkers, if any, should be used. At the end of the first week, a hanging or automatic feeder should be switched to.

Considering the length of the day, the lighting should be arranged as 20 hours of light and 4 hours of darkness. The European Union imposed the requirement of a total of 6 hours of darkness per day, 4 hours without interruption. To facilitate the access of chicks to feeders and drinkers and enable them to get used to them, 24 hours of lighting should be provided at a light intensity of 10 Watt/m^2 for the first 3 days. In the period until the slaughter, the light intensity should be adjusted to 2 Watt/m^2 in the application of 20 hours of light and 4 hours of darkness. The height of the light source from the litter can be up to 2 m. It is beneficial to have a generator to prevent panic and consequential losses that will occur in case of power cuts.

It is necessary to ventilate the poultry house in order to provide sufficient oxygen, to expel the harmful gas and dust particles formed in the poultry house, and to ensure that the humidity inside the poultry house is at an appropriate level. Manual or mechanical ventilation systems can be preferred not to impair the temperature and humidity balance in the house. During the construction of houses, the most appropriate and economical ventilation system is planned, considering the local climatic conditions.

2. GENOTYPE

The basic principle is that animals to be used in organic production consist of animals for breeding who are resistant to diseases and highly adaptable to the environment and climatic conditions, whose genetic structure has not been changed, who are taken from organic enterprises and fed with organic feeds (Öztürk et al., 2013). Moreover, it is more appropriate to use lines improved in terms of yield for economic production (Eleroğlu et al., 2014).

Organic line development studies suitable for production purposes continue, and economic value loss occurs in the use of local genotypes in production. There are views stating that the genotypes used in conventional production can also be used in organic production, provided that the standards are followed (Zeltner & Maurer, 2009). However, if these lines are used, genotype × environment interaction is observed (Kjaer et al., 2001; Sørensen, 2001), and there are problems in meeting the requirements of small enterprises (Boelling et al., 2003). Furthermore, in the case of using lines developed for conventional production in organic broiler production, welfare problems such as lameness, culling, and mortality occur due to excessive weight gain, and it is recommended to use slow-growing broiler lines in organic production systems (Castellini et al., 2008).

The regulation adopted by the Turkish Ministry of Agriculture and Forestry on organic farming (OTE, 2010) concerning the principles of organic farming and the standards set by the European Union (EC, 2007) imposed restriction on age at slaughter, thus preventing the use of fast-growing lines.

The fact that the finishing period is more than two months ensures that chickens remain mobile during the finishing (Castellini et al., 2008), and the use of slow-growing lines reduces the incidence of skeletal disorders.

The use of male chicks after hatching of eggs obtained from animals for breeding improved in terms of eggs in the production of organic broiler chickens causes inefficiency, and the use of hatched chickens in finishing should be taken into account as a situation that may undermine consumer trust (Zeltner & Maurer, 2009).

Lines with high adaptation in comparison with conventional production should be used in organic production, and the use of aggressive or cowardly genotypes should be avoided. Ferrante et al. (2008) reported that broilers used in organic production exhibited less reaction to humans when they compared organic and conventional production systems. The high level of adaptation to humans and the environment is also considered an indicator of animal welfare.

In line with all these developments, slow-growing broilers, which can reach 2.2-2.5 kg slaughter weight between 80-120 days, suitable for organic, free-range, or extensive breeding systems, have been developed as an alternative to fast-growing broilers (Sarıca and Yamak, 2010). In organic broiler farming, genotypes with high adaptability to environmental conditions and resistance to diseases are selected. In organic broiler farming, the minimum age at slaughter is 81 days in case of using fast-growing chicks and 72 days in case of using slow-growing genotypes. Chicks should be obtained from breeding enterprises licensed and certified by the Ministry of Agriculture and Forestry.

3. FEEDING

Organically produced roughage and chopped feeds are used. Antibiotics, coccidiostats, medicinal products, and other substances that increase growth or production cannot be used in animal feeding.

Chicks should be fed with broiler chick feeds for the first 28 days and with broiler feeds until the slaughter age after the 28th day. The use of feed additives, additives that help in the feed processing, products used in feeding, genetically modified organisms and products obtained from them, except those allowed in organic standards, is prohibited in organic broiler production.

The most significant problem in the feeding of organic poultry is the balanced and economical preparation of the ration. Along with the prohibition of synthetic amino acids and other feed additives, the quality and economic supply of organic certified feed raw materials takes place among the challenges (Eleroğlu et al., 2014; Yıldırım & Eleroğlu, 2014).

The problems experienced in producing organic feed have increased studies on the development of feeding techniques with low protein content and insufficient amino acid balance and the development of genotypes with high tolerance to these deficiencies (Sørensen, 2001; Elwinger et al., 2008). A selection study conducted in the generation fed with rations with low protein levels prepared from locally sourced feeds showed that cannibalism was most common in lines fed with low protein feeds, the dependence on soy in the ration could be reduced, and local feed sources (beans, faba bean, peas, lupine, etc.) could be used more (Elwinger et al., 2008; Yıldırım & Eleroğlu, 2014). To prioritize the use of local feed sources, feed ingredients and contents used in slow-growing organic broiler rations are given in Table 1 (Yıldırım & Eleroğlu, 2014).

In organic broiler farming, the requirements in terms of essential amino acids can be met more easily than layer chickens. The reason for this is that slow-growing lines are used in organic broiler production and the amount of protein they require is lower compared to fast-growing lines (Zollitsch & Baumung, 2004).

To prepare organic layer chicken feed, 16% crude protein and 2400 kcal ME content can be reached with the use of 50% grain mixture (wheat, triticale, corn, barley) and 35% expeller soybean and sunflower meal, 5% alfalfa flour and 10% mineral resources (marble powder, salt, etc.) and premix.

Table 1. Raw Materials (%) and Nutrient Composition (g/kg) of Organic Broiler Feeds Prepared According to Different Age Periods

Feed raw material	Days 0–28	Days 29–81	Days 82–98
Barley	3.45	4.50	4.50
Vegetable oil	4.36	5.00	5.00
Wheat bran	5.00	5.00	5.00
Wheat	12.40	4.00	4.00
Rye	3.00	4.00	4.00
Corn	40.00	20.00	20.00
Triticale	-	22.00	32.00
Oats	2.10	5.00	-
Fish meal	7.30	5.00	-
Soybean meal	20.00	22.00	22.00
Dicalcium phosphate	1.10	2.10	2.10
Marble powder	0.74	0.80	0.80
Salt	0.30	0.30	0.30
Vit.-min.premix*	0.25	0.30	0.30
Calculated nutrient composition			
	Days 0–28	Days 29–81	Days 82–98
ME (MJ/kg)	13.00	12.72	12.91
Dry matter	899.00	903.00	901.00
Crude protein	197.00	201.00	180.00
Crude ash	4.70	5.90	4.80
Lysine	10.80	10.60	8.50
Methionine + Cystine	6.60	6.70	5.90
Threonine	7.30	7.20	6.20
Calcium	10.00	11.60	9.00
Phosphorus	7.70	6.00	5.90
Sodium	1.90	1.80	1.50
Tryptophan	2.40	2.60	2.50
Linoleic acid	31.9	32.1	31.3

* Each kg of vitamin-mineral premix contains vitamin A, 4400000 IU; vitamin D_3, 1600000 IU; vitamin E, 20000 mg; vitamin K_3, 1600 mg; vitamin B_1, 1200 mg; vitamin B_2, 3200 mg; vitamin B_3, 20000 mg; vitamin B_5, 6000 mg; vitamin B_6, 1600 mg; vitamin B_9, 800 mg; vitamin B_{12}, 8 mg; biotin, 80 mg; antioxidant dry, 50000 mg; Cu, 6000 mg; Fe, 20000 mg; Mn, 48000 mg; Se, 80 mg; Zn, 40000 mg; Co, 80 mg; I, 500 mg.

To prepare broiler feed, approximately 20% crude protein and 2900 kcal ME content can be reached with 50% grain mixture and 44% expeller sunflower and soybean meal, 2% corn gluten feed, 1% vegetable oil and 3% mineral and premix source. However, the methionine content should not be less than 0.3% in the egg feed to be prepared, and the lysine content should not be less than 1% in the broiler feed (Zollitsch & Baumung, 2004).

4. PASTURE

Although it varies depending on climatic conditions, poultry should be able to reach open-air houses, and this should be applied in at least 1/3 of their lives. Free-range areas are mostly covered with vegetation. An area of 4 m^2 per chicken (provided that it does not exceed the limit of 170 kg /N/ha/year) should be provided for the free-range requirement. Vegetation regrowth is also allowed between two rearing periods.

The most important feature in the organic production system that increases animal welfare is the amount of open space allocated per animal. The management of this area, which can also be called organic chicken pasture, influences poultry health, feeding, and production efficiency.

While a 1 m^2 barn area for 6 animals and a 4 m^2 free-range area per animal are estimated for layer hens, a 1 m^2 barn area for 10 animals or 21 kg of live weight and a 2.5 m^2 free-range area per animal are estimated in fixed houses for broiler farming, and a 1 m^2 barn area for 16 animals or 30 kg of live weight and a 4 m^2 free-range area per animal are foreseen in portable houses (Öztürk et al., 2013). The utilization of the free-range area, which is approximately 4 times the size of the barn area, in the most appropriate way is important in terms of environmental health as well as animal health and should be managed in a way that will affect productivity positively.

Plant design, management, and maintenance are among the prominent subjects in this field.

It will be beneficial to create a plant pattern that will allow poultry to provide some of the nutrients they need from organic chicken pasture (Image 3).

Common bird's-foot trefoil
Lotus corniculatus

Awnless bromegrass
Bromus inermis

Image 3. Plants that can be used in chicken pasture

Considering that chickens can meet 20-30% of their nutritional needs from organic pasture, necessary arrangements should be made in the feed formulation (Şahin et al., 2004). Hence, there is a need for research stating that focusing on natural or artificial pasture forage crops rich in aromatic and unsaturated fatty acids (especially omega 3 and 6) will have a positive effect on organic poultry meat quality. Apart from this, for example, the natural pasture crop caper, with a kind of appetizing property can be considered.

Common bird's-foot trefoil (*Lotus corniculatus*) and awnless bromegrass (*Bromus inermis*) plants were mainly used in the chicken pasture created at the organic poultry production research site of Sivas Cumhuriyet University. Common bird's-foot trefoil species originating from the Mediterranean basin, including our country, are commonly found in natural meadows and pastures in Turkey (Davis, 1970; Houerou, 2001). Moreover, it is a leguminous forage crop that is highly tolerant to all kinds of soil structures, salty, acidic, unproductive, with a low soil depth and poor drainage (Manga et al., 1995). Considering the chemical structure of poultry manure, common bird's-foot trefoil can be considered an important plant in creating organic pasture. Especially *Lotus corniculatus* subsp. Decumbens, among the creeping types of common bird's-foot trefoil, can be used to enrich grazing areas or create artificial grazing areas (Houerou, 2001; Diaz et al., 2005).

According to the results obtained from studies on the feed quality of common bird's-foot trefoil, the nutritional value of the plant is very similar to that of alfalfa and meadow clover (Cassida et al., 2000).

Awnless bromegrass, which is a long-lived, drought, heat and cold-resistant Poaceae forage crop, is of great importance both in the renewal of deteriorated pastures and in the establishment of artificial meadows in field lands (Serin et al., 1999).

Being highly adaptable to the region, being perennial, and being resistant to the chemical structure of chicken manure are among the leading features sought in the plants to be selected to create organic poultry pastures. Geographical and ecological differences significantly affect the plant pattern to be selected. The nutrient contents of dry grass obtained from the organic poultry pasture established in Sivas

Cumhuriyet University are presented in Table 2 below (Eleroğlu et al., 2014, Yıldırım & Eleroğlu, 2014).

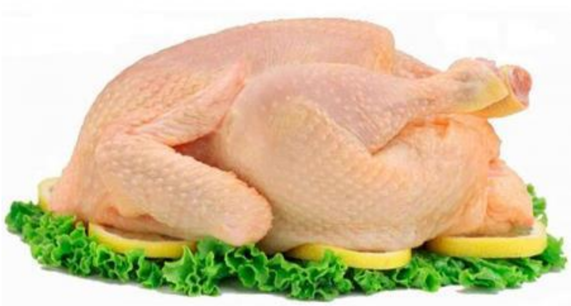
Table 2. Chemical Structure of Naturally Dried Chicken Pasture, (%, DM)

Characteristics	Amount
Dry matter	94.91
Crude protein	17.85
Crude cellulose	25.81
Crude ash	11.80
Crude fat	1.86
Starch	5.40
Sugar	2.88

5. TRANSPORTATION AND SLAUGHTER

Animals are transported in a stress-free way and in a short time. Loading and unloading are performed carefully and without the use of an electrical stimulating device to force animals. No sedatives are used before and during transportation.

In land transportation, there is a break every 8 hours for feeding, watering, and resting. Slaughter animals are treated in a way that does not cause stress during slaughter. Organic animals are slaughtered after the slaughterhouse and combines are cleaned with permitted substances after the slaughter of chickens.



6. HEALTH

In organic animal farming, preventive medicine is essential for animal health. Breeds appropriate for breeding are selected. For regular exercise that will increase the natural immunity of animals, access to free-range areas or grazing areas and the use of quality feed are provided. In case of an animal's illness or injury, despite all preventive measures, it is isolated in a suitable house and treated immediately. Chemically synthesized veterinary medicinal products or antibiotics cannot be used for disease prevention practices (Çınar & Çatlı, 2020).

Health is one of the important criteria of animal welfare. It is reported that the incidence of parasitic diseases in organic production is higher than that in conventional farming (Lund & Algers, 2003).

Dermanyssus gallinae (Maurer et al., 1993; Höglund et al., 1995; Fiddes et al., 2005), also known as "poultry red mite" or "roost mite," *Eimeria* spp. causing coccidiosis (Häne, 1999; Shirley et al., 2005), and *Ascaridiagalli* and *Heterakis gallinarum*, among the gastrointestinal helminths in chickens (Permin et al., 1999; Heckendorn et al., 2009; Maurer et al., 2007), are among the most important parasites in layer chickens.

There is an intermediate situation between prohibiting or allowing the use of synthetic acaricides in the control of *D. gallinae* or allowing it: Natural acaricides should be primarily used in the control of D. *gallinae* (EC, 2007), but synthetic acaricides can be used as a last resort. Practical applications such as successful flock management, the prevention of physical contact between flocks, and the use of acaricides of natural origin can yield results in the fight against diseases (Maurer et al., 2009a).

It has been reported that there is a difference in the count of Eimeria spp. oocytes excreted between those visiting the open area and those not visiting it, this count is higher in those visiting the open area, and the results may vary according to the litter condition (Häne, 1999).

Vaccination against Eimeria spp. is suitable in layer and broiler chickens and is widely used in organic flocks, and a significant decrease in the rate of coccidiosis is reported (Shirley et al., 2005).

It has been indicated that helminths are an important risk factor in free-range farming systems (Permin et al., 1999, Häne, 1999). Helminth parasites can be combated in the flock with regular worming drug treatment. However, the regular and preventive use of these chemical synthetic drugs is not compatible with organic regulations, and therefore, there is a need to develop alternative strategies with preventive care and feeding.

It is stated that protective-preventive care strategies developed against intestinal helminths have a lower effect in poultry farming compared to ruminants due to their different epidemiological structures (Maurer et al., 2007). For example, although applying the placement density as 5 m^2/chicken and changing the free-range space increased walking ability, it did not have an effect on helminth infection (Heckendorn et al., 2009). Likewise, helminth infection was not affected by the litter type used (Maurer et al., 2009a). Alternative applications against intestinal helminths have been used by many researchers. However, the efficacy of herbal treatments against A. galli and H. gallinarum infections is usually limited to in vitro studies.

Zoonotic diseases do not pose a risk to animal welfare. However, this problem is more common in organic poultry farming since they contact more external factors such as wild birds in the open area. Studies conducted to determine the prevalence of Campylobacter reported that although the incidence was 37% in conventional flocks, this value was 100% in organic flocks (Heuer et al., 2001; Engvall, 2001; Rodenburg et al., 2004). It was reported that approximately 80% of Pasteurellosis cases in poultry were caused by free-range farming (Christensen et al., 1998). It was reported that the incidence of Salmonella in broiler production was not affected by rearing systems and was approximately 13% (Rodenburg et al., 2004).

7. CONCLUSION

The difficulties encountered in the transition from conventional production to the free-range production system also emerge in the organic production system, and the production cost increases within the framework of mandatory standards. In addition to practical applications, benefiting from local feed sources is important in producing high-quality products at marketable costs. There is a need for studies on herbal applications both in the fight against diseases and increasing the rate of feed-use efficiency. Furthermore, there is a need for special lines developed for organic meat and egg production and the development of appropriate housing techniques to ensure high yields from them. The genotype to be used in production, the plant pattern in the pasture, the housing system, and natural feed additives may differ locally.

In organic production, which is much more affected by the environment than conventional production, the applicability of the research conducted and the results obtained may also be variable.

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CHAPTER 8

ENCOURAGEMENT OF ORGANIC AND BIODYNAMIC BEEKEEPING FACILITIES FOR SUSTAINABLE BEEKEEPING

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INTRODUCTION

Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony (USDA, 1995).

Organic beekeeping, which aims to produce healthier and higher quality bee products, has just started to develop in Turkey. In colonies traditionally fed with sugar and sugar syrup, chemical pesticides used in the control of bee diseases and pests leave residues in colonies and bee products. Besides, the price difference between traditionally produced honey and organically produced honey is high, which causes limited production of bee products.

Biodynamic beekeeping is an approach that emphasizes the preservation of the welfare and health of bees. There is no official record of biodynamic beekeeping practices in Turkey yet. In addition, biodynamic farming practices and the ecosystem created by these practices provide a perfect biosphere to benefit from this biodiversity for the unique pollinator honeybees, which are an integral part of nature. It is very important for Turkey to take its deserved place in the world rankings by training beekeepers on organic and biodynamic beekeeping and emphasizing the importance of producing 'clean bee products' for public health.

1. ORGANIC BEEKEEPING

Organic agriculture is a system that preserves the balance in nature, ensures the continuity of soil fertility, controls diseases and pests, creates the continuity of living things in nature, and makes productivity sustainable with the most appropriate use of natural resources. Organic beekeeping is a part of organic animal husbandry, which is an animal production system that is carried out in a controlled and certified manner with organic production techniques for consumers who demand high quality, healthy and risk-free products.

Organic beekeeping defined as in the process of collecting nectar, pollen, water and propolis in nature and transforming them into various bee products without artificial feeding and using chemicals at all stages, in organic farming areas or in the naturally structured flora. The qualification of beekeeping products as organic production is closely related to the characteristics of the hives and environmental quality. Organic beekeeping is a controlled and certified production model, made with only permitted materials without the use of harmful chemicals, from production to consumption. Beekeeping is an important activity that contributes to the protection and development of the environment. For this reason, beekeeping is of great importance in organic farming activities. While very valuable bee products are obtained in organic beekeeping areas, it also contributes to increase the quality of plant production through pollination. For this reason, organic beekeeping should be done in agricultural areas where organic agriculture is applied.

1.1. Organic Beekeeping in Turkey

In terms of the presence of bee colonies and honey production, Turkey has a very important place in the world and has a very high potential due to the geographic and climatic structure of the country. It is also very rich in terms of plant diversity, approximately 40% of which is endemic. In addition, genetic diversity of honeybee races and sub-species is unique in Anatolia.

As of 2019, China ranks first in world honey production with 444 thousand tons, Turkey ranks second with 109 thousand tons of production, and Canada ranks third with 80 thousand tons. In the number of hives, India is the leader with 12.3 million hives. China ranks second with 9.1 million hives, while Turkey ranks third with 8.1 million hives.

According to Organic Agriculture Statistics of Ministry of Agriculture and Forestry, in 2020, the total number of organic beekeeping apiaries in Turkey was 387, and the total number of hives in these apiaries was 70 285. The total amount of organic honey produced for 2020 has been reported as 1 028.39 tons (Table 1).

Table 1. Organic Beekeeping Data in Turkey (2020)

City	Bee Product	Number of the apiaries	Number of hives	Amount of the production (tons)
Adıyaman	Honey	27	2 165	47.75
Afyonkarahisar	Honey	1	220	2.50
Ankara	Honey	1	30	0.85
Artvin	Honey	31	2 653	24.45
Aydin	Honey	3	1 094	25.30
Balıkesir	Honey	1	45	0.47
Bayburt	Honey	71	9 948	156.65
Bingöl	Honey	2	1 750	22.20
Bitlis	Honey	1	995	27.50
Çanakkale	Honey	11	917	9.78
Çorum	Honey	1	115	0.80
Elâzığ	Honey	33	3 742	29.56
Erzincan	Honey	6	1 571	7.35
Erzurum	Honey	9	2 214	25.22
Gaziantep	Honey	2	642	6.87
Gümüşhane	Honey	31	2 052	17.61
Hakkari	Honey	1	130	0.12
İstanbul	Honey	1	110	3.00
İzmir	Honey	2	455	10.65
Kars	Honey	3	1 190	15.97
Kayseri	Honey	1	50	0.30
Konya	Honey	1	127	3
Mersin	Honey	25	6 935	143.13
Muğla	Honey	1	355	3
Muş	Honey	6	1 854	43.00
Ordu	Honey	4	2 833	55.75
Rize	Honey	5	625	7.45
Siirt	Honey	4	1 141	17.56
Sivas	Honey	9	2 704	39.68
Şirnak	Honey	1	732	4.20
Trabzon	Honey	11	4 238	86.35
Tunceli	Honey	13	2 427	10.07
Van	Honey	35	12 825	175.99
Yalova	Honey	9	349	1.50
Yozgat	Honey	1	105	0.82
Zonguldak	Honey	23	1.047	2
Total		**387**	**70 385**	**1 028.39**

Organic Agriculture Statistics (Ministry of Agriculture and Forestry, 2020)

Considering the transition process to organic beekeeping data in 2020, it is reported that only the number of transitional apiaries is 107, and the number of organic and transitional beekeepers (apiaries) is 10. The total number of hives in the transition period in these apiaries was reported as 18 743.

1.2. Principles of Organic Beekeeping Practices

The key issues of production in organic beekeeping are; the characteristics of the hives, the environmental conditions and the quality of the apiary, the good manufacturing practices, storage, processing and marketing of bee products. In the places where the organic beekeeping enterprise is located, other beekeeping enterprises must also comply with the principles of organic beekeeping. In this case, a one-year period is given to the beekeeping enterprise for the transition from conventional production to organic production, and it is tried to comply with organic production principles. Before this period, the beekeeping enterprises are not allowed to sell products under the name of 'organic'. For this reason, beekeepers who decide to engage in organic beekeeping within the framework of cooperation with the Ministry of Agriculture and Forestry and certification bodies should be identified and followed closely during the transition period.

1.2.1. Structure of hives and origin of the bees

The origin of the bees used in the hives is important in organic production. When determining the bee breed to be used in organic production, disease-resistant ecotypes that can best adapt to regional conditions should be preferred. Due to the widespread practice of migratory beekeeping in our country, there are a large number of different ecotypes of bee populations. Since each ecotype provides the most suitable adaptation to its own region and environmental conditions, the concept of ecotype should be carefully considered in performance evaluation and bee breeding studies.

Hives should be created by dividing colonies or by taking swarms or beehives from plants that comply with the provisions of this regulation.

1.2.2. Environmental conditions

The placement of the hives on the apiary is another important issue. Bee transfers should be done stress-free and in a short time. Enough natural nectar sources, pollen sources and clean water supply should be provided for the bees in the place where the bees are taken. It should be noted that unclean water sources are an important factor in the spread of disease. Organic plant production should be done or natural vegetation should be found in the areas within a 3 km radius of the hive area. Hives should be located away from industrial areas, highways and conventional agricultural areas where pesticides are using.

1.2.3. Hives

Hives used in organic beekeeping must be made of natural materials. Only wax, resin, propolis or plant oils should be used for painting the hives. The disinfection of the hives should be done by burning with a blowtorch. Other beekeeping materials should be disinfected using boiling water, caustic soda and natural plant extracts. The propolis coating method that is easily applicable is recommended for the preparation of hives for organic production. In addition, by the effective collection and preparation of propolis that can be obtained from the colonies, the outer surfaces of the hive can be made ready for organic production both extremely cheaply and in a healthy way.

1.2.4. Honeycombs

During the transition period from conventional production to organic production, all the honeycombs in the hive should be replaced with organic honeycombs. Organic beeswax should be used. In case of using non-organic beeswax, residue analysis should be performed to prove that there are no chemical or antibiotic residues in the wax. One of the biggest problems in organic beekeeping in our country is the production of 'organic beeswax'. It is not possible for a beekeeping practice that does not use organic beeswax to talk about the production of 'organic honey'.

1.2.5. Bee colony

In organic beekeeping enterprises, bee colony is obtained either by taking artificial swarms from organically produced enterprises or by transferring conventional bees to organic honeycomb frames. The need for queen bees can serve the purpose by obtaining 10% of queen bees per year from colonies which engaged in artificial insemination or conventional production. It is allowed to kill the old queen during the renewal of queen bees, but cutting the wings of the queens is prohibited.

1.2.6. Feeding the colonies

Enough honey and pollen should be left in the hives for a comfortable wintering at the end of the production season in the organic apiary. In organic beekeeping, the feeding of bees should be done with organic honey obtained from their own hives. However, in cases where artificial feeding is necessary, organically produced honey and pollen or organically produced sugar syrup or organic sugar molasses are used. Sugar, molasses, milk, glucose and other conventional substances are not allowed to use. No additives should be added to the syrup prepared with organic honey for the purpose of strengthening the colonies. Feeding should be stopped 15 days before the nectar flow. The next feeding should be done after the last honey harvest.

1.2.7. Keeping records

Every application made in the apiary (queen change, swarm, comb production, honey extracting, feeding, drug use, transportation, etc.) must be recorded in the hive as regular basis. Also feeding type, feeding interval, amount of the product used and the number of the beehives that fed should be specified in these records.

1.2.8. Controlling the diseases

Disease-resistant breeds and ecotypes should be studied, queen bees should be renewed regularly, regular disease and pest control should be carried out in the hives, drone larvae should be inspected, hive materials and tools should be disinfected, new combs should be used, and sufficient food sources should be left in the hives to be protected from diseases and pests in beekeeping. If colonies damaged by pests and diseases despite protective measures, they should be treated promptly with isolation in separate areas. A transition period should be applied to colonies in organic production that are treated. Chemical compounds should not be used as a preventive measure. Prophylactic synthetic applications should not be made (such as the use of antibiotics against foulbrood). Educating beekeepers on the subject, providing information on the subject with the publication studies to be carried out, encouraging the use of organic chemicals in the fight against bee diseases and pests should be considered as measures to be taken.

1.2.9. Organic control with Varroa pest

Organic acids such as formic acid, lactic acid, acetic acid, oxalic acid and essential oils such as mint, thyme, eucalyptus or camphor can be used to fight against Varroa that is the most common and harmful pest of the honeybee. Nowadays, studies on human health and food safety are carried out intensively. At this point, natural substances that do not have harmful effects on human health and do not carry residual risk in bee products have started to be sought for the control of varroa. In addition, essential and volatile fatty acids have also given successful results in the control of varroa without creating a residual risk in bee products. Since drone cells are preferred by varroa because it finds the most comfortable growth opportunity, another control method, which is very suitable for the organic concept in the fight against Varroa, is the destruction of drone cells, which is called the 'Biological method'. With this method, drone cells that develop on the honeycomb surface, especially in early spring, are destroyed and prevent the development of varroa.

2. BIODYNAMIC BEEKEEPING

Beekeeping practices have changed and developed over the years. Thus, new applications for beekeeping activities and new beekeeping methods have emerged. While commercial beekeeping has become industrialized, the honey that is a unique product that is made by the bee has become a part of the economy. The methods used on bees to get more efficiency caused the emergence of stress factors in bees, and problems such as loss of yield and colony deaths began seen. The basic rule of a sustainable and efficient beekeeping is to know the honeybee, to know the right care management in the bee colony, and to implement these studies by taking into account the health and welfare of the bee. This situation paved the way for “Biodynamic Beekeeping”, an approach that will emphasize the protection of the welfare and health of bees.

Although Biodynamic Beekeeping emerged at the beginning of the 20th century, it gained its real development towards the end of the 20th century. Currently, there are over 100 beekeepers in the world certified by Demeter. An increasing number of beekeepers in Europe for hobby purposes are engaged in biodynamic beekeeping. It is estimated that around 2% of existing bee colonies in Germany are engaged in biodynamic beekeeping. There is no official record of biodynamic beekeeping in Turkey yet.

2.1. Principles of Biodynamic Beekeeping Practices

Biodynamic agriculture developed as the first ecological farming system offered as an alternative to chemical agriculture. Demeter is the brand for products from biodynamic agriculture. Foods that are grown with the biodynamic farming method are far superior to the foods produced by the conventional method in terms of nutrients, and moreover they are more delicious. Demeter was established in 1928. It prepares a certification program for products obtained from biodynamic agriculture to make this quality sustainable. Biodynamic beekeeping is also included in this concept.

2.1.1. Placement of beehives

For the placement of apiaries, it is preferred that clean lands with biodynamic and organic applications or uncultivated lands should be selected. The place selected for the apiary, there should be vegetation that can provide enough pollen and nectar sources to each bee colony and the number of beehives should be planned accordingly. Also, in the placement of the hives places where the bee colony will not be affected by environmental contaminants should be chosen. The selection of areas free from environmental pollution is important. If migratory beekeeping is carried out, the places should be planned in advance, the route should be determined, bee colonies should be taken to nectar areas by short-distance transport and all these stages should be recorded. It should be careful to the absence of any polluting elements such as thermal power plants, mines and quarries, highways, waste centers, factories, within a radius of six kilometers which is considered as the flight distance, near the area where the apiary is located.

2.1.2. Apiary

The material from which beehives are made is entirely made of natural materials such as wood, clay or wicker, except for the hive cover and the wires in the frames.

2.1.3. Internal applications

For protection purposes, only beeswax and propolis which supplied from Demeter beekeepers can be applied inside the hives.

2.1.4. External applications

Only natural, ecologically safe and non-synthetic wood preservatives such as linseed oil, propolis, beeswax can be applied to the outside of the hive.

2.1.5. Cleaning and disinfection

Cleaning and disinfection of hives can only be done by burning with a blowtorch (flame machine) or mechanically using hot water.

2.1.6. Colony growth and selective breeding

Swarming is a natural method to increase the number of colonies. The production of queen cells is seen as a part of the swarm instinct. For reproduction to continue in the swarming process, it is allowed to replace the old queen and to create artificial swarms by using the division method in strong colonies with new queens at the appropriate time. Exceptions are only possible in certain cases and with the approval of the international or relevant national certification body. The production of queen bees by artificial methods is prohibited. Bees or queen bees should be purchased from beekeepers who follow the Demeter rules. However, if this is not possible, queen bees can also be obtained from organic certified beekeepers. In biodynamic beekeeping, cutting the wings of queen bees and artificial insemination are not allowed.

2.1.7. Methods to increase honey production

Multiple merging of colonies as well as systematic bee replacement are not allowed. Bees should not be seen as a modular system for honey production but should be considered as a super organism that is the basic requirement of life. Some of the honey produced by the colonies must be left as a winter food stock to meet the basic life needs of the bees, considering the strength and needs of the colony.

2.1.8. Honeybee races

Local races and ecotypes that can adapt to the local vegetation should be selected.

2.1.9. Honeycomb

All the honeycombs in the hive must be natural honeycombs, all of which are naturally made by the bees. Natural honeycombs can be placed on frames. The use of thin wax basic honeycombs, which can be mounted on the frame, to direct the relief of the honeycomb is permitted. Beeswax used for routing strips or partitions should be combs or beeswax that are obtained from Demeter beekeepers. If it is not possible to find honeycomb or beeswax this way, beeswax from certified organic sources can also be used. Usage of conventional honeycombs should be finished gradually within 3 years at the latest, or they should be replaced with honeycombs or wax from Demeter beekeepers.

While choosing the hatchery and frame size of the hive, it should be considered that the hatching can develop naturally with the honeycomb and not be blocked by the boards. The use of partition sets is not allowed in biodynamic system. However, there may be exceptions during the transition period. Beeswax must not meet solvents, thinners, bleaches or similar materials, and the containers and equipment used must be made of or coated with natural materials that do not oxidize. The use of recyclable beeswax is not allowed in biodynamic beekeeping.

2.1.10. Feeding the colonies

Honey and pollen are natural foods for bees. The main purpose in biodynamic beekeeping is to overwinter the colony with its own honey. In cases where this is not possible, the additional winter food to be used should contain at least 10% honey by weight. This honey must come from a Demeter certified source. Natural plant extracts that have strong antibacterial effects, such as chamomile or thyme tea, can be added to the supplemental winter food. All feed additives must be of biodynamic origin or organic origin. In cases where feeding is required before the first nectar flow of the season, the winter application is applied. If urgent feeding is required at the end of the beekeeping season and before the last harvest of the year only Demeter honey should be used. The use of sugar is not allowed in such feeds. In addition, feeding stimulants and the use of any substance that can replace pollen are not allowed.

2.1.11. Honey harvest and storage

During the harvest, filtering, straining, and bottling of the honey, the temperature should not exceed over 35℃. Pressure filtration and additional heat application should not be applied to honey. As a rule, honey should be filled into a glass jar or steel container, where it will be sold immediately after the harvest and without any solidification in its structure. Honey should not meet air and should be stored in a place out of sunlight and at a constant room temperature.

2.1.12. Bee health

In biodynamic beekeeping, a bee colony is expected to be strong enough to fight the diseases and pests that may appear in the hive on its own. The Demeter beekeepers should aim to increase and protect the bee population of the hive with the measures it takes. Sometimes, the extinction of colonies when they are unable to resist diseases and pests is accepted as a part of natural selection.

2.1.13. Transition and certification process

A transition period of at most 3 years is required for full certification in biodynamic beekeeping. If 12 months have passed since the last application of the substances that should not be used and the old wax used in the honeycombs has been replaced with a certified organic origin wax, the beekeeper can be given the status of 'Demeter in Transition'. If the original wax analysis at the beginning of the transition period or the first year of the transition period proves that the wax is pure, an initial wax replacement is not necessary. The controller may request to take wax samples. If the beekeeper demonstrates competence and fulfills the Demeter Standards and conditions at the end of the process, he/she is entitled to receive a Demeter beekeeping certificate.

2.1.14. Identification of Demeter bee product

In order to be able to market and sell certified bee products produced by a Demeter beekeeping enterprise, these bee products must comply with national organic regulations. Products such as honey, beeswax and propolis can receive certificates. Certification of these is done by organizations that can give Demeter certification. In biodynamic beekeeping, the production of bee products such as pollen, royal jelly, bee venom, apilarnil, queen bee larvae are not allowed.

3. CONCLUSION

The practices used in conventional beekeeping aim to get more efficiency from the bee by ignoring the welfare of the bee. As a result of this situation, when the bees get stressed and their welfare level decreases. The deterioration of the welfare of the bees leads to a decrease in the bee resistance, becoming more susceptible to diseases and pests, and as a result of all this, the bees lose their lives. Environmental pollution due to excessive use of chemicals in agriculture in recent years has led to rapid increase in colony losses and further questioning of the safety of bee products obtained from the hive.

In order to take its place among the few countries in the world in organic honey production as well as in conventional honey production, it is necessary to implement more effective colony management, reduce the cost by increasing unit production per colony, educate beekeepers on organic honey production and emphasize the importance of "clean" honey production in terms of social health.

However, the concept of biodynamic beekeeping is still very new for Turkey. In biodynamic beekeeping, bee and community health, food safety and quality are prioritized compared to the amount of yield obtained. The return of conventional beekeeping to “good manufacturing practices” is important for bee health and hygiene of bee products. As a result, organic and biodynamic beekeeping needs to be supported to protect the health of the bee and community.

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CHAPTER 9

ORGANIC AQUACULTURE

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INTRODUCTION

Hunger, which is advancing with the growing world population, has great importance. For this reason, investigations on people's balanced nutrition are increasing rapidly. In addition to being accessible and economical, it is of great importance in the preference of food to contain important food components such as proteins, lipids, carbohydrates, vitamins, and minerals in a balanced proportion. The first of these foods is fishery products (fisheries and aquaculture). According to FAO (2021), fish accounts for approximately 17% of the total global animal protein and 7% of all protein. Aquaculture production in 2018 is 179 million tons. 156 million tons of this production are reserved for human consumption. From 1990 to 2018, global fisheries production increased by 14%, global aquaculture production increased by 527%, and total fish consumption for food purposes increased by 122%. In 2018, total global fisheries production reached the highest level ever recorded at 96.4 million tons, an increase of 5.4 percent from the previous three years' average.

Aquaculture is the cultivation of aquatic animals and mostly aquatic plants consisting of algae, including finfish, crustaceans, molluscs, etc., using or in areas of freshwater, marine and brackish water.

Turkey's fishery production in 2020 decreased by 6.1% compared to the previous year to 785 811 tons. In 2020 46.4% (364 400 tons) was obtained from aquaculture and 53.6% (421 411 tons) from fisheries.

According to Turkish Statistical Institute (TUIK), aquaculture in Turkey is developing and during the period 2000-2020, cultured fish production in Turkey increased by 532% from 79 031 tons to 421 411 tons (Figure 1).

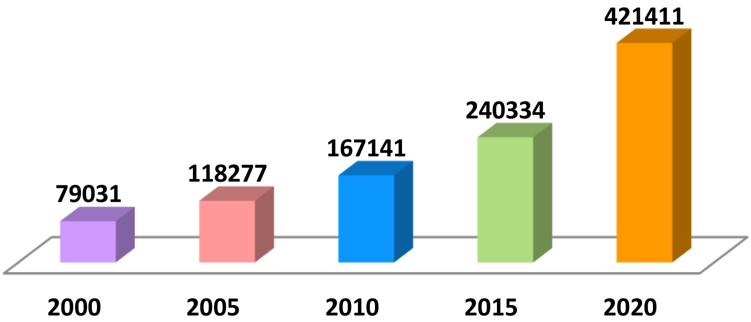

Figure 1. 2000-2020 years Turkey aquaculture quantity (tons) development (TUIK, 2021).

Farming increased by 12.9% in 2020. In 2020, 18 aquaculture species were cultured in Turkey. Of these species, 35% (148 907 tons) of European sea bass, 31% (127 905 tons) of rainbow trout, and 26% (109 749 tons) of sea bream cover about 97% of the total production (Figure 2).

In 2020, 293 175 tons of production through farming took place in the marine and 128 236 tons in inland waters. The most important fish species grown was rainbow trout (*Onchorhynchus mykiss*) with 127 905 tons in inland aquaculture, European seabass (*Dicentrarchus labrax*) with 148 907 tons, and gilthead seabream (*Sparus aurata*) and sea bream with 109 749 tons in marine aquaculture.

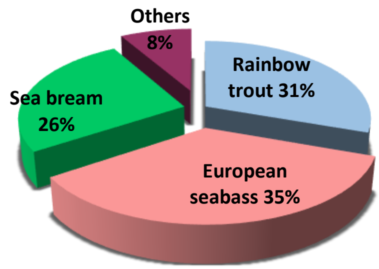

Figure 2. Aquaculture in Turkey on a species basis for 2020 (%) (TUIK, 2021).

The other most important vital in aquaculture, feed costs account for 40-60% of production costs in aquaculture. Currently, global animal feed production has reached 1.2 metric billion tons, while fish feed is estimated to exceed 40 million tons in this production. Organic aquaculture is a sub-segment of organic agriculture and is under the roof of organic agriculture.

1. ORGANIC AGRICULTURE

Recently, interest in organic agriculture has increased in Turkey and it is frequently raised. However, since everyone has no common definition, these definitions can cause some controversy and disagreements. According to the definition technically framed by the United States Department of Agriculture: "Organic farming; Fertilizer with synthetic content is a production system that prohibits or greatly avoids the use of pesticides, growth regulators and animal feed additives. To the extent possible, organic farming systems are based on product debate, plant residues, animal manure, legumes, green fertilization, organic farm resides and biological pest control processes to process soil and maintain its productivity, provide plant nutrients, control harmful insects, weeds and diseases" (Demiryurek, 2011).

1.1. International Organizations Operating in the Field of Organic Agriculture

Although the countries have various organizations to develop organic agriculture within themselves and exchange information among those who adopt these farming methods, international organizations have also been established to develop organic agriculture. These are the International Federation of Organic Agricultural Movements (IFOAM), The Food and Agriculture Organization of United Nations (FAO), the International Trade Center (ITC), the Organic Trade Association (OTA).

1.2. Organic Agriculture in Turkey

The beginning of organic farming in Turkey first began in 1984-1985 based on contracts between producers and European importers (Merdan, 2014). In 1984-1985, there are no legal regulations about organic agriculture in our country, Turkey.

'Regulation on the Ecological Production of Vegetable and Animal Products' numbered 22145 Official Gazette, came into force in December 1994 as first legal regulation. While Organic Agriculture Law determines the establishment and institutionalization structure of organic agriculture, the Regulation defines the principles of the execution of organic farming practices. In light of the additional changes in the relevant legislation of the EU, this regulation was revised to "Principles and Implementation of Organic Agriculture Regulation" dated October 17, 2006, numbered 26322 Official Gazette. The Ministry of Agriculture and Forestry is one of the leading organizations operating in the field of organic agriculture in Turkey. Organic agriculture records are monitored by the General Directorate of Plant Production by recording in the system by the ministry. All plant and animal organic production records carried out domestically are monitored by the organic agriculture information system (OTBIS). In addition, the Ecological Agriculture Organization Association (ETO) and Aegean Exporters' Associations operate in the field of organic agriculture.

2. ORGANIC AQUACULTURE

2.1. History of Organic Aquaculture in the World

Historically, it has been known that the foundations of organic aquaculture are based on the beginning of the organic farming movement and these foundations contributed to the shaping of the sector in many ways. First, in the early 1990s (1994), farmers and organic farming associations in Austria and Germany began to develop extensive organic carp farming. There was no export or access to large audiences in small production (IFOAM EU Group, 2010).

This changed in 1995 with the launch of the first organic salmon farming project in Ireland. Then, the introduction of organic salmon farming, first in Germany, then in the United Kingdom and France, led to the acceleration of organic aquaculture initiatives worldwide (IFOAM EU Group, 2010).

Another milestone in the history of organic aquaculture is the development of standards for growing organic shrimp. With the support of the German company Gesellschaftfür Technische Zusammenarbeit (GTZ), Naturland, and an international online forum, the standard setting process was started in 1998 with the participation of the round table in Ecuador. As a result of the preparations, after the idea of growing organic shrimp as a polyculture in mangrove forests, it finally completed the first organic shrimp production in Ecuador in 2000 (IFOAM EU Group, 2010).

Following the production of organic salmon and organic shrimp, which is in demand in Asia, Europe, and Latin America, organic trout and production were started. Binca Seafood, a German-based aquaculture company, started organic Pangasius catfish farming in Vietnam. Following this study, organic tilapia farming in Israel, Ecuador, and Honduras; in Mediterranean countries, steps have been taken to grow organic marine fish (Sea bream and sea bass) (IFOAM EU Group, 2010).

2.2. Organic Aquaculture Production Quantities

With the regulations made in China, 72 enterprises have been certified for the production of polyculture of carp, trout, crab, turtle, and sea cucumber species in a small organic production area. In Europe, the favorite product of organic farming is Atlantic Salmon (*Salmo salar*), which has been made from Mediterranean species of sea bass and sea bream, freshwater salmonids (rainbow trout and brown trout), and carp. In Latin America, there is a strong dominance of organic white shrimp production in Ecuador, Peru, and Brazil. The most common production in China is the production of polyculture carp, together with crabs, shrimps, and other species. There are also approved initiatives that produce turtles or sea cucumbers. The importance of the production of black tiger shrimp in Asian countries (Bangladesh, India, Thailand, and Vietnam) is increasing. In addition, microalgae production in India and catfish production in Vietnam are among the trends in organic aquaculture (IFOAM EU Group, 2010).

The quantity of organic aquaculture in the world was 53 500 tons in 2009 and USD 300 million in value, including a 0.1% share of the total amount of aquaculture (Prein et al., 2012).

Global organic aquaculture production reached 181 146 tons in 2013 and 690 000 tons in 2019 (Figure 3; Table 1, 2) (FiBL, 2021).

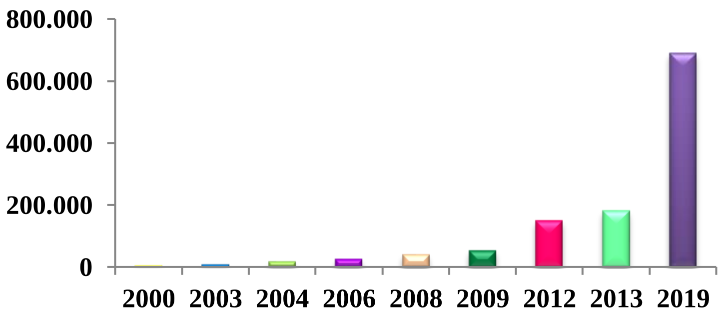

Figure 3. World organic aquaculture production quantity by year (tons).

Table 1. World Organic Aquaculture Production Quantities (Tons) (FiBL, 2021) by country in 2019

COUNTRY	QUANTITY (Tons)
China	561 200
Ireland	27 264
Chile	26 000
Norway	17 771
Iceland	17 482
Holland	8 536
Spain	7 062
Bulgaria	5 004
Hungary	2 970
Other	26 771
Total	690 000

In Europe, the favorite products of organic aquaculture were Atlantic salmon, Mediterranean species sea bass and sea bream; freshwater salmonids, and carp. In Latin America, there is a strong dominance of organic white shrimp production in Ecuador, Peru, and Brazil.

The importance of the production of black tiger shrimp in Asian countries (Bangladesh, India, Thailand, and Vietnam) is increasing. In addition, microalgae production in India and catfish production in Vietnam are among the trends in organic aquaculture.

Table 2. World Organic Aquaculture Production Quantity by Species in 2019 (FiBL, 2021)

SPECIES	QUANTITY (Tons)
Sea bass	244
Shrimp	382
Other Trout	560
Carp	1 574
Rainbow trout	1 581
Sturgeon	1 766
Salmon	16 361
Mussel	27 315
Algae	41 383
Other	223 000
Total	690 000

2.3. Organic Aquaculture in Europe

According to EUROSTAT (2021), European organic aquaculture production was 33 260 tons in 2012, 70 848 tons in 2015 and 102 719 tons in 2019. (Figure 4).

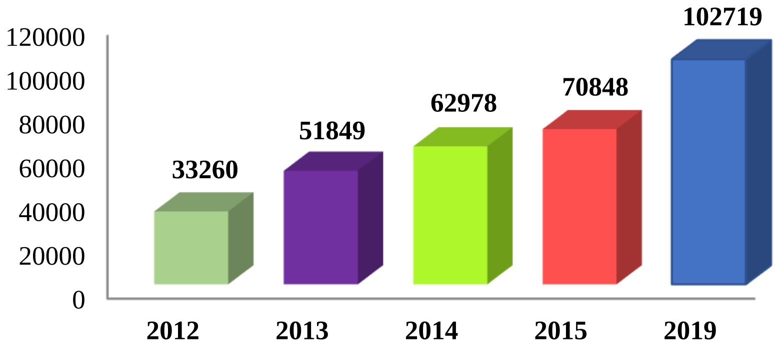

Figure 4. EU organic aquaculture by year (Tons) (EUROSTAT, 2021).

In 2013, European organic aquaculture production to approximately 29% of the world's organic aquaculture production amount, which decreased to 14.8% in 2019 (Figure 5).

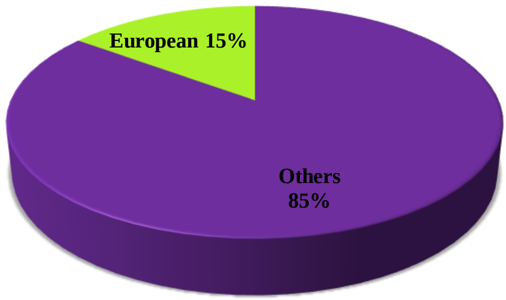

Figure 5. 2019 EU share in world organic aquaculture production (%).

If we consider EU organic aquaculture production on a species basis, mussels are the most common species in organic aquaculture production in Europe (reached 17 467 tons in 2015 from 1 402 tons in 2014 and recorded as 22 059 tons in 2019).

2.4. Organic Aquaculture in Turkey

For the first time in Turkey, organic aquaculture was carried out in Rize in 2010 as a total of 456 tons, including Rainbow trout and Black Sea trout (Çavdar, 2011).

The main topics on organic aquaculture published in the Official Gazette in 2010 in our country are "Regulation for Principles and Implementation of Organic Agriculture" is classified as General Rules in Organic Sea Weed Production, General Rules in The Production of Organic Aquaculture, Special Rules for Organic Bivalve Molluscs, Prevention of Diseases and Storage of Veterinary Products, Veterinary Treatments.

Organic aquaculture varies according to species and breeding place (earth pool, concrete pool, cage etc.) as fish, crustaceans, mollusks, and algae, but is generally based on the following main principles (Table 3).

Table 3. General Rules of Organic Aquaculture

General Rules in Organic Aquaculture
1-Aquatic environment and compliance of sustainable management plan
2-Simultaneous production of organic and non-organic aquaculture
3-Origin of organic aquaculture
4-Origin and management of non-organic aquaculture
5-Aquaculture application conditions
6-Special rules for aquaculture units
7-Management of aquaculture

8-Culturing rules
9-Use of hormone and hormone derivatives
10-Rules on feed for fish, crustaceans
11-Transition period in aquaculture
12-Rules for transporting live fish
13-Product control considerations
14-Records and documents that the entrepreneur must have

6 enterprises engaged in organic fish farming in Rize Province, Directorate of Provincial Agriculture and Forestry, and 1 enterprise engaged in organic marine fish farming in Muğla Province.

2.5. Evaluation of Organic Aquaculture Enterprises in Turkey

In Turkey, 8 aquaculture enterprises were included in the project to produce organic fish with a project initiated by the Rize Directorate of Provincial Agriculture and Forestry on November 12, 2006, but 6 of these enterprises received "entrepreneurial certificates" and started to produce organic fish under supervision of control and certification entity (gradually in 2008-2009).

6 organic trout enterprises started to operate in Rize and produced 456 tons/year in 2010. Rainbow trout (*Oncorhynchus mykiss*) constituted 431 tons of this production and Black Sea trout (*Salmo trutta labrax*) made up the remaining 25 tons.

Marine organic fish cultivation in Turkey started to be carried out by only one enterprise in 2013. Kılıç seafood produced 559 tons of organic gilthead sea bream and European sea bass in 2015.

2.6. Current Problems and Expectations

In our study, producers who do not state very important and insurmountable problems other than the problem of feed supply, the inadequacy of regulations on organic aquaculture in Turkey, the deficiency of studies, the lack of acknowledgment of organic fish, confusion of the concepts of organic production and natural production, the lack of promotion and advertisements. They expressed their problems such as the concern that organic fish will not be in demand in the country and expressed their desire to revise and increase these, and they talked about their expectations for more producers to attempt organic production.

Despite such market demand, organic fish, which is met with great interest in the domestic and foreign markets, has not been produced since 2011. In the 6 enterprises that completed the transition process, organic fish production lasted 1-2 seasons due to feeding shortages due to low organic production capacity and producers could not agree. In this process, since the producers who renewed the entrepreneur's certificate did not qualify for product certificates, they attempted to continue production by buying organic imported feed between 01.10.2013-01.06.2015, but when they could not realize their ideas, traditional production was returned.

2.7. Assessment of Organic Aquaculture in Turkey

To gather the information obtained, 2 of the 8 enterprises that applied as a result of the fact that the water used did not meet the appropriate criteria in the standards regulated about organic fish culturing and the proximity of the enterprises to the settlements. As a result of the reasons, 2 of the 8 enterprises that applied were not entitled to receive a certificate and the project was taken into the certification process by the international organic certification organization ICEA and started production with 6 enterprises. The feed used by the enterprises was prepared with dedication by organic standards within the framework of organic fish feed ration limits by project officials in the agricultural provincial directorate and experts in the feed company in the factory of a private company in the country and again it was certified and offered for sale by ICEA.

Although these 456 tons of organic fish produced are fanatically exported, they have been sold to the public in important organic food markets in the country, most of them due to the desire to introduce the people to organic fish at the request of the producers. Some of the producers "organic making-conversion" their brood stock during the transition period and some met their fries with imports. There was no problem in the enterprises intertwined with nature in the process and the transformation process was efficient and effortless.

Since 2010, if the idea of farming organic marine fish in various enterprises in the Aegean Region was put forward, no progress could be begun until 2014. In 2015, the Ministry of Agriculture and Forestry reported that in 2014, only 1 enterprise (Kılıç Seafood) in Muğla Province applied for a transition period for the production of organic gilthead sea bream and European sea bass, and continued this period in

2014 with 617 988 fry European sea bass and 655 133 fry sea breams. In addition, it is official records that the same company produced 1 231 382 organic sea bream-sea bass and 1 295 277 transitional fry gilthead sea bream and European sea bass in Muğla in 2015. In the same years, a group of trout farms in the Fethiye region of Muğla also took steps to do organic farming, but no activity was started.

Although Turkey has water resources and facilities that are very suitable for organic aquaculture production, the development of organic aquaculture in Turkey is not so developed in the world (Arslan & Akhan, 2018). Also, ecological features vary by region in Turkey. For this reason, Turkey should establish its own legal regulations and standards on the basis of region-based scientific studies (Kayhan & Ölmez, 2014).

Organic aquaculture, which is a sustainable, ecological, and environmentally friendly method, is a winning issue that is too important to ignore both its contribution to the natural ecosystem, its economic return, and its benefits in terms of taste and health.

As a result, we believe that organic aquaculture products can reach the value they deserve faster as a result of solving problems such as regulation of the legislation on organic aquaculture, improvement of support policies (additional support for organic aquaculture was ended in 2016), solving problems related to the supply of organic feed, increasing the recognition of organic certified fish on the counter by consumers, and raising awareness of consumers. To keep ourselves and our future generations healthier, we should expand organic fish production in Turkey and ensure that its consumption is given importance.

Acknowledgments

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CHAPTER 10

IMPORTANCE OF MEADOWS, RANGELANDS AND SHRUBLANDS FOR ORGANIC ANIMAL HUSBANDRY IN TURKEY

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INTRODUCTION

A system, called as "green revolution", was adopted and implemented in the 20th Century aimed to targeting the high production and intensive usage of inputs as well as the research studies regarding to plant and animal breeding in agriculture in order to adequately feed the rapidly increasing human population in the world (Wu & Butz, 2004). During this process, despite increasing land scarcity and values, the developing world has witnessed an extraordinary increase in the productivity of food products over the past 50 years. Although, the population has more than doubled, grain production has tripled during this period, with only a 30% increase in cultivated land area (Wik et al., 2008). This system has been continued to be successful until the last few decades despite of the imbalances in agricultural production and food distribution by countries. However, the increasing demand for food has forced for more production. More production required the usage of more inputs. As a result, food safety has been weakened and serious environmental problems (soil and water pollution) have been experienced. In this situation, researchers looking for a way out have sought alternatives such as organic (ecological) agriculture and sustainable agriculture, and they also started to take benefit from gene technology.

Certain amount of yield is sacrificed and safe food production is ensured in organic production system, where the usage of chemical inputs is allowed to a limited extent (Çakmakçı & Erdoğan, 2012). Along with organic crop production, the demand for organic animal products has also been increased. Organic feed production was inevitably needed for organic livestock raising. Roughages are the basic feed sources which are mostly needed for ruminant animals. Nutritional values and digestibility are obtained from high quality roughage, fodder crops produced in agricultural ecosystems, and meadows and rangelands, which are included in semi-natural ecosystems. Along with these, shrublands, an important part of natural ecosystems, are also important and generally high-quality roughage sources.

In this chapter of the book; the importance, existence and potentials of meadows, rangelands and shrublands, which are valuable forage resources of organic livestock farming in Turkey, are discussed. Some of the data used in this chapter are taken from Gökkuş (2019).

1. IMPORTANCE OF NATURAL FORAGE AREAS

Natural meadows and rangelands are the roughage production areas which are formed spontaneously under the influence of existing climate and soil factors. However, human intervention in the form of harvesting and grazing also has an important role in formation the vegetation. Particularly, in the Eastern Anatolia Region, where meadows are common, early grazing and bottom cuttings have led to a decrease in the production potential (approximately 50-80% of the potential can be produced) of vegetation and changes in the botanical composition. In the same way, untimely and heavy grazing of rangelands also affected the yields and their floristic composition. Because of this, only 13% of the rangelands of Turkey are in good and very good condition (Avağ et al., 2012).

Meadows and rangeland areas differ in terms of their location, vegetation structure, production status, usage patterns and ownership status. Meadows are generally located on the lowland, vegetation is dense and tall, dry matter production is high, generally cutting and most of them are privately owned. In contrast, rangelands are located on rough terrains devoid of groundwater, vegetation is sparse and short, grazing is the most economical form of use, and owned by the government (Altın et al., 2011a). Herbaceous species dominated and woody plants (particularly, shrubs) also appear in some parts of the rangelands. The ownership of the rangelands by government, on the one hand, makes it difficult to use them in accordance with the management principles, on the other hand, it limits the use of inputs for productivity and quality increase. As in the arid and semi-arid rangelands of the world (Whitehead, 2000), chemicals such as fertilizers or pesticides are not used in the rangeland areas of Turkey. The absence of chemical inputs makes these forage production areas indispensable for organic livestock raising. Although it is generally privately owned, there is no chemical use in meadows, most of them (58.2%) are located in the Eastern Anatolia Region. The same condition also prevails for shrublands.

2. NUTRIONAL VALUES OF NATURAL FEED AREAS

In Turkey, the vast majority of meadows and rangelands vegetation consists of cool climate plants. Such plants grow well in the spring season. In autumn season, these plants produce some green forage depending on the amount and time of precipitation. Natural multispecies meadows and rangelands also produce high quality forage in spring and autumn seasons, as the plants have the highest nutritional value at their green stages. For instance, the crude protein ratios of hay in Eastern Anatolian meadows vary between 7.20-9.83% (Gökkuş, 1989), 11.39-13.25% (Gökkuş, 1990) and 8.7-13.2% (Kaya et al., 2003) according to region and harvesting time. In case of Marmara Region, the crude protein ratio of meadow hay has been recorded as 7.78% for the average of two years and four harvestings (Doğan, 2011). In Turkey, according to the studies carried out in different regions, it has been emphasized that the crude protein ratios of natural rangeland forages vary between 14.82-16.07% in Bursa (Bayram, 2005), 7.8-8.7% in Burdur (Demirel, 2016), 11.79-12.95% in Bartın (Genç Lermi & Altınok, 2018), 13.23% in Erzurum (Aslan, 2019), 14.3-16.1% in Bingöl by direction and 10.7-21.1% by time (Tarhan & Çaçan, 2020) and 5.38-10.64% in Aydın according to the slope (Sürmen & Kara, 2018) during active growth periods.

The crude protein ratio of hay of meadows and rangelands falls below 5% that dry out in summer season (Koç & Gökkuş, 1996a). For example, the crude protein ratios of herbaceous species varied between 4.60-5.24% during the period of June-September in two separate rangelands (dominated by shrubs) of Çanakkale, located in the Mediterranean belt (Özaslan Parlak et al., 2011). Such condition shows that the herbaceous layer is far from meeting the nutritional (protein) needs of the animals grazing during the resting period in summer. Because ruminants grazing on rangelands need to consume feed containing at least 7% crude protein in order to maintain their metabolism (Milford & Minson, 1968; Meen, 2001). Organic additional protein sources are needed in this case.

The abundance of species diversity of meadows and rangelands, the high nutritional value in their green stages, importance in brood breeding, suitability for animal welfare, being the protector of animal health and the cheapest source of roughage (Altın et al., 2011a) make them unique for organic livestock.

Most of the shrubs, especially evergreen ones, can be browsed throughout the year and they generally retain higher levels of protein, phosphorus, carotene, lignin and fiber in winter, although, their nutritional values decrease less from summer to winter as compared to the herbaceous species (Wikeem & Wikeem, 2005). On the other hand, deciduous shrubs can provide sufficient forage in summer and autumn seasons when herbaceous species are found insufficient. Both of the evergreen and deciduous shrubs can produce sufficient and quality green forage for animals, mostly when herbaceous species are dry (Papanastasis, 1999; Alatürk et al., 2014). However, in the research conducted in Western Anatolia, it has been reported that the deciduous shrubs can meet the crude protein required for grazing animals in spring, summer and autumn seasons, while evergreen shrubs contain lower protein shown in Figure 1. In arid regions, the delicate shoots and leaves of legume shrubs are often the main source of feed for livestock (Topps, 1992). The higher protein (14.0-25.8%) and metabolic energy values (8.4-14.4 MJ/kg) (Devendra, 1992) along with the digestibility

(Papachristou & Papanastasis, 1994) of leguminous shrubs make them valuable feed sources for animals.

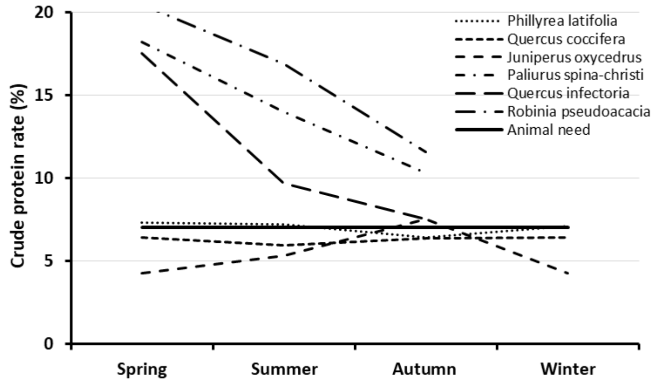

Figure 1. Year-round Variation of Crude Protein Content of Some Shrubs Common in the Mediterranean Maquis (Prepared from the Data of Alatürk et al., 2014).

Some of the studies carried out to determine the nutritional values of shrub species in the shrublands of Turkey are given in Table 1. Accordingly, common types of maquis formation generally provide enough forage to meet the protein needs of year-round browsing animals.

Table 1. Crude Protein Rates of Some Selected Shrub Species in Turkey

Species	Sampling time	CP (%)	Location	Reference
Berberis vulgaris	August	11.82	Erzurum	Güven, 2004
Colutea armenea		21.05		
Rosa canina		12.74		
Cotoneaster nummularia		16.32		
Paliurus spina-cristi	May	22.04	Çanakkale	Özaslan Parlak et al., 2011a
	August	10.06		
	October	8.47		
Quercus infectoria	April	18.00		
	August	10.97		
	October	7.97		
Calligonum polygonoides ssp. *comosum*	April	25.29	Iğdır	Oktay & Temel, 2015
	July	12.46		
	October	7.54		
Paliurus spina-cristi	Spring	12.41	Kilis	Dökülgen & Temel, 2015
	Summer	9.25		
	Autumn	8.61		
Paliurus spina-cristi	Spring	8.42	Bingöl	Kaplan et al., 2017
	Summer	8.12		
	Autumn	7.81		
	Winter	4.38		
Robinia pseudoacacia	Spring	11.51		
	Summer	10.94		
	Autumn	9.81		
	Winter	9.50		
Rosa canina	Spring	8.90		
	Summer	6.89		
	Autumn	6.44		
	Winter	4.08		
Quercus coccifera	April	13.74	Uşak	Yüksel & Arslan Duru, 2019
	July	11.27		
	October	9.49		
	January	9.56		
Juniperus oxycedrus	April	5.07		
	July	6.63		
	October	5.68		
	January	4.87		

3. PRESENCE OF MEADOWS, RANGELANDS AND SHRUBLANDS

In Turkey, the total area classified as meadows and rangelands is 14,616,687 hectares, which consists of 13,167,374 hectares of rangelands and 1,449,313 hectare of meadows (TÜİK, 2020). Their distribution by regions is given in Table 2. Meadows are common in the Eastern Anatolia Region. More than half (57.4%) of the total meadow areas is in this region. Black Sea (17.1%) and Central Anatolia Regions (13.7%) are in the 2nd and 3rd place in terms of meadow areas. Meadows are scarce in the coastal regions of Southeastern Anatolia and southern and western Anatolia. All of the hay produced here is preserved by drying.

Table 2. Distribution of Meadow and Rangeland Areas by Region in Turkey (Area is given as 1000 ha, Rate is given as %) (Calculated from the Data of the Turkish Statistical Institute)

Regions	Total area	Rangeland		Meadow		Range+Meadow	
		Area	Rate	Area	Rate	Area	Rate
East Anatolia	16,355	4,861	29.7	831	5.1	5,692	34.8
Central Anat.	19,802	4,704	23.8	198	1.0	4,902	24.8
Black Sea	11,642	1,269	10.9	248	2.1	1,517	13.0
Southeast A.	6,175	749	12.1	40	0.6	789	12.7
Marmara	7,276	519	7.1	51	0.7	570	7.8
Mediterranean	9,034	631	7.0	45	0.5	676	7.5
Aegean	7,496	435	6.3	36	0.5	471	6.8
Total	77,783	13,168	16.9	1,449	1.9	14,617	18.8

The natural rangelands, which is mostly composed of herbaceous species, spreads mainly in the Eastern and Central Anatolian Regions where the continental climate prevails. Such climate makes possible the formation of steppe cover in these regions. Sheep and goats (especially, sheep), and cattle (local and crossbreed) are raised based on rangelands depending on the land structure and the characteristics of the vegetation and animal breeds. Black Sea Region, particularly with its alpine rangelands (plateau) located at the upper border of the forest, produces high quality roughage that animals use in summers. Therefore, Eastern and Central Anatolia and the Black Sea are regions with high potential for meadow and rangelands based organic animal husbandry.

An important issue regarding meadows and rangelands is the uncertainty over their area. Agricultural census results based on field data arranged by the Turkish Statistical Institute in the year 2001. On the other hand, the total rangeland area has been determined as 16.3 million hectares in the National Rangelands Use and Management Project (Project No: 106G017) supported by TÜBİTAK and carried out by the General Directorate of Agricultural Research and Policy (TAGEM) in 48 provinces of the country (Avağ et al., 2012). The total meadow and rangeland areas have been estimated to be approximately 18 million hectares with the second project carried out subsequently by TAGEM (Aydoğdu et al., 2020). Whereat, it can be said that these natural roughage sources are actually a little more suitable for organic animal husbandry.

In Turkey; shrublands are an important source of roughage, where animals partially benefit and would benefit from, described as degraded forest, although, forest area is included in this class. Degraded forests are considered those forests where the tops of trees cover less than 10% of the area (OGM, 2012). In other words, there are no trees found in

90% of such areas. These parts are covered with shrubs and herbaceous species. Such vegetation is generally called as "browsing land" and mainly utilized by browsing the livestock in the world. Degraded forests, namely shrublands, cover about 9.7 million ha in Turkey (Table 3).

Table 3. Distribution of Degraded Forest Areas by Regions in Turkey (OGM, 2021)

Regions	Degraded forest (Shrublands)		Range + Meadow + Shrubland	
	Area (1000 ha)	Rate (%)	Area (1000 ha)	Rate (%)
East Anatolia	1,320	8.1	6,865	42.0
Central Anat.	1,523	7.7	6,355	32.1
Black Sea	1,587	13.6	3,243	27.8
Southeast A.	1,078	17.5	1,755	28.3
Marmara	678	9.3	1,456	20.0
Mediterranean	1,826	20.2	2,725	30.2
Aegean	1,644	21.9	3,681	49.6
Total	9,657	12.4	26,080	33.5

Vegetation, mostly consisting of shrubs, are defined as degraded forests are common in the Aegean and Mediterranean regions where the Mediterranean climate is dominant. In these regions, shrublands establish up to 21.9%, and 20.2% of the total area. On the other hand, shrub formation covers the least area in the Eastern and Central Anatolian Regions (8.1 and 7.7%) where rangelands and meadows are most common.

Shrubs, used as forage sources, are also unique sources that lighten the load of rangelands. Shrubs; (a) a constant forage bank to buffer seasonal fluctuations that occur in arid and semi-arid areas, (b) a supplementary protein for livestock on poor native rangelands or consuming low-quality roughages, (c) a mean of soil erosion control, and (d) a fuel source for low-income farmers (Chriyaa, 2005).

4. PRODUCTIONS OF MEADOWS AND RANGELANDS

In Turkey, the number of animals that can be grazed in the areas classified as meadows and rangelands resulting after the calculation done according to regions, is given in Table 4 and Table 5. As a result of the calculation made on the basis of the roughage needs of the animals in terms of their survival rate, it is understood that the meadows have the capacity to feed the animals equivalent to a total of 0.9 million AU. Naturally, more than half (59.1%) of this capacity is constituted by the meadows of the Eastern Anatolia Region.

Table 4. Number of Animals could be Fed on Meadows in terms of Region in Turkey

Regions	Yield* (ton/ha)	Area (1000 ha)	Produced total hay (1000 ton)	Feedable AU
East Anatolia	3.00	831	2493	546,411.0
Central Anat.	2.50	198	495	108,493.2
Black Sea	3.00	248	744	163,068.5
Southeast A.	2.50	40	100	21,917.8
Marmara	3.00	51	153	33,534.2
Mediterranean	2.75	45	124	27,178.1
Aegean	3.00	36	108	23,671.2
Total	-	1,449	4217	924,274.0

AU: Animal unite. Animal equivalent to a cow weighing 500 kg.
* Yield values are taken from Altın et al. (2011a).

On the other hand, rangelands can produce hay that will meet the roughage requirements of the animal, which is equivalent to 3.9 million AU in total during the grazing season. Eastern Anatolia (50.3%) and

Central Anatolia (25.6%) Regions have the largest production as well the grazing capacity.

Table 5. Grazing Capacities of Rangelands in terms of Regions in Turkey

Regions	Area (1000 ha)	Yield* (kg/ha)	Total grazable hay (1000 ton)	Grazing season (day)	Grazing capacity (AU)
East Anatolia	4,861	800	3,888.8	160	1,944,400.0
Central Anat.	4,704	500	2,352.5	190	990,526.3
Black Sea	1,269	1000	1,269.0	210	483,428.6
Southeast A.	749	450	337.1	220	122,581.8
Marmara	519	600	311.4	210	118,628.6
Mediterranean	631	600	378.6	270	112,177.8
Aegean	435	600	261.0	225	92,800.0
Total	13,168		8,798.4		3,864,543.1

*Yield values indicate the amount of grazable hay. Amount of grazable hay was accepted as half of the dry hay yield. Values are taken from Altın et al. (2011a).

Plateaus are high altitude rangelands within the rangeland classification. They are found in mountainous areas and have a shorter grazing season than that of other rangelands because of these features. Because, the atmosphere temperature decreases as the altitude increases, and the suitable growth period for plants is shortened (Andiç, 1993). That is why, as a result of grazing in the rangelands which are near to the village, and after the reduction and drying of forages depending on the season, animals are taken to the plateaus that are still green and have just reached the grazing maturity. Cows are decorated and festivals are held during taking the animals to the plateau in the Black Sea Region as shown in Figure 2. This allows the animals to graze onto the rangelands for a longer period of time with green as well as the quality forage. Although, plateau livestock raising still continues to exist despite of the decrease in transhumance activities due to the decrease in the rural population in current years. Plateau animal husbandry maintains its importance especially; in Eastern Anatolia, Black Sea and Mediterranean Regions which have mountainous terrain. Since the plateau areas of Turkey are evaluated within the rangeland class, that is why, they are not specified separately in the statistics.

Figure 2. Decorated Domestic Cows are on the Way to Go to the Plateau in the Black Sea Region (Photo by Fahri Kıraslan).

5. PRODUCTION POTENTIAL OF SHRUBLANDS

A significant part of the shrublands is located in those areas of the Aegean and Mediterranean Regions where the Mediterranean climate is dominant (Table 5). The Black Sea Region has a pseudo-maquis formation established by shrub-tree species (Atalay, 1994).

Table 6. Amount of Grazable Forage Produced in Shrubby Areas and the Number of Animals would able to Feed on Them

Regions	Area (1000 ha)	Yield (kg/ha)	Total production* (1000 ton)	Feedable animals AU
East Anatolia	1,320	800	1055.9	231,430.1
Central Anat.	1,523	800	1218.7	267,112.3
Black Sea	1,587	1200	1904.8	417,490.4
Southeast A.	1,078	800	862.5	189,041.1
Marmara	678	1200	813.9	178,389.0
Mediterranean	1,826	1000	1825.7	400,153.4
Aegean	1,644	1000	1644.2	360,372.6
Total	9,657		9,325.7	2,043,988.9

*Grazable forage amount

The unavailability of obvious data on the area covered by the shrubs, and the production potential for each region makes it difficult to evaluate the grazing capacity of these areas. Generally, the amount of grazable forage in shrublands is higher than that of the herbaceous rangelands (Papanastasis & Mansat, 1996; Tsiouvaras et al., 1999; Özaslan Parlak et al., 2011). However, the actual grazing portions are lower than that of the calculated amounts because of their large heights, leaves are found out of the reach, having thorns etc., like structures that make grazing difficult, and production of chemicals that reduce plant density and flavor of some of the shrubs. According to the estimates reported from some previous studies that the amount of hay that animals can graze in shrublands can be accepted as 1200 kg/ha in the Marmara Region (Gökkuş et al., 2011). It is stated that the grazable forage will not exceed 1000 kg/ha, and has a grazing capacity of less than 10 sheep or goat per hectare per year in Mediterranean maquis covers (Le Houerou, 1981). The yield values given in Table 6 were taken as a basis for calculating the amount of grazing forage produced in the shrublands based on these research findings in terms of ecological factors and observations. As a result of the calculation done by using these data, the total amount of forage produced in shrublands, and available to animals can be estimated to be 9.3 million tons. This figure is above the total amount of useful forage (8.8 million tons) produced in rangelands. It is a very important feed source for farm animals (particularly for small ruminants). In Turkey, the total number of goats (11,985,845 heads) is mostly fed in these areas (TÜİK, 2020). Despite this, the feed produced in shrublands far exceeds the feed requirement of the animals. Because the shrublands can meet the year-round roughage needs of animals which is equivalent to 2 million AU, and this is equivalent to about 1.7 times the total goat presence (1.2 million AU) in Turkey. However, it should not be forgotten that a significant number of sheep are also browsed in these shrublands. Although, these areas are browsed all year-round despite of the absence of any visible deterioration in the vegetation indicates that there is no intensive use.

The main problem here is that these areas can be browsed on a limited basis since they are included in forest range. However, despite the legal restriction, these areas are browsed by the villagers who are settled over here. Since, classifying the shrublands as "browsing land" and opening them up for browsing will not only give relief to small ruminant breeders living in these areas, but will also provide important solutions to the nutritional problems already existed in animal husbandry. Additionally, it should not be forgotten that the most economical use of these areas is browsing. Certain parts of the forest areas are allowed for browsing as a result of such conditions, and also considering the social and economic problems which arose in these areas, with the regulation issued by the General Directorate of Forestry published in the Official Gazette No. 28350, dated: 11.07.2012. However, this is quite inadequate to use the potential in this regard.

6. IMPORTANCE OF MEADOWS, RANGELANDS AND SHRUBLANDS IN ORGANIC ANIMAL HUSBANDRY

Human influence on the formation of vegetation is more limited since meadows, rangelands and shrublands have natural vegetation unlike agro-ecosystem. The most important human impact on these areas is related to cutting, grazing and browsing. Although, meadows are generally private lands while the rangelands are under the rule and disposal of the state, and the right of use has been given to the people who are living in village, town or district in Turkey. Ownership status of a place is decisive in the management and improvement of that area. In fact, the rangelands are in public domain often causes not enough care in their use, and avoidance of improvement works when necessary. Additionally, in fact, the rangelands are not used correctly and almost no regulation is made about their improvement, especially; no use of pesticides, paves the way for organic animal husbandry.

Rangeland improvement works have been carried out on only 1.3 million ha of land as in the year 2020 with the rangeland improvement and management projects in accordance with the Rangeland Law No. 4342 (BÜGEM, 2020). Although, fertilizers and herbicides were used in these projects with a duration of 3-5 years, but these practices were not sustainable, generally, after the projects were completed and the contribution from government was stopped. Therefore, there is no application of pesticides and other chemicals in the rangelands that cause harm to organic livestock raising. On the other hand, vegetation will not tend to deteriorate if rangelands can be grazed in accordance with management principles, and in this case, there will be no need of chemical/pesticide application for the improvement of rangelands.

The vegetations of rangelands produce balanced and high-quality forage due to their species diversity. Therefore, this situation increases the quality of animal products, too. Conjugated linoleic acid, found in milk and meat and is extremely important for human health, increases in animals grazing on rangelands (Kurban & Mehmetoğlu, 2006). Natural rangelands are indispensable, especially for brood and young animals, and they are the cheapest roughage sources (Altın et al., 2011a). Because the breeders who benefit from these rangelands generally do not pay any kind of fee other than the shepherd's charges. Even the grazing costs cannot be collected in the Rangeland Law.

Rangelands are the most important areas in terms of animal health. Grazing of animals in the open field increases their muscle and bone development, regulates their nervous system and blood circulation, improves their sexual activities, prevents their hoof disorders, and increases resistance against colds and bacterial diseases. Moreover, it also eliminates diseases caused by the deficiencies of vitamin and minerals (Altın et al., 2011a). As a result, there is less need for veterinary services and thus, the risk of using chemicals is also reduced, which is undesirable for organic animal raising.

Rangeland grazing is important for animal welfare. The ability of animals to graze freely and to fulfill the requirements for their comfortable survival within certain limits helps to obtain quality products by improving their quality of life.

Although, the meadows are mostly privately owned, that is why, it cannot be said that the inputs used in these areas will pose a problem for organic animal husbandry. There is no use of chemicals for the development of vegetation, especially, in the Eastern Anatolia region where meadows are commonly found. Dung ash is rarely applied in the meadows of this region. The animal from which the dung is obtained is also from the same ecosystem.

There is no input used in shrublands, and even browsing creates legal problems into it. On account of this, these areas are also ideal for organic livestock raising. Shrubs produce a more balanced forage than that of herbaceous species throughout the year (Ibrahim, 1981). They preserve their nutrient contents to a certain extent, even if it decreases, especially in summer and winter months when herbaceous rangelands dry up or their production stops (Alatürk et al., 2014). In particular, leguminous shrub species draw attention with their high protein contents (Kökten et al., 2012).

7. EVALUATION

In Turkey, there are 24.3 million ha of land where 14.6 million ha of meadows and rangelands, and 9.7 million ha of shrubland (deteriorated forest) can be directly grazed and fed by animals. The said areas constitute 31.2% of the total area. The total amount of usable forage, produced here, is approximately 18.1 million tons. This amount constitutes the 23.2% of 77.9 million tons of roughage share required for the annual survival of livestock of our country (Hanoğlu & Gökkuş, 2021). Furthermore, there is no use of any input that may be objectionable in terms of organic livestock raising during the production of such huge forage resource. It can easily be seen that these natural forage production areas of Turkey have a very high potential for organic livestock raising, if considering how large the share of roughage in animal nutrition is.

Meadow hay contribute to meet a significant part of the roughage needs of animals mostly in winter, herbaceous rangelands in spring and partly in autumn, and grazing lands throughout the year, especially in summer and winter, in the system where animals take benefit from natural meadows and rangelands. Nevertheless, the forage production is not sufficient in every season of the year. Fodder crops should be produced into the organic system, so that, it would be able to eliminate the roughage deficiency, especially in summer and winter months when the forage deficiency arises.

Meadows are used by cutting, that is why, the forage is dried and then given to animals at their shelters. Eastern Anatolia, where the most meadow areas are located, is the region with the shortest grazing period (about 150-180 days) with its high altitude and harsh winters, on the other hand, it is the region with the longest period of stay of the animals in the shelter. Organic meadow hay is also used in this region to meet the roughage needs of animals for a long time. In Central Anatolia, in addition to the longer grazing period (about 180-200 days), the less produced meadow grasses are also important organic roughage sources for the animals in the shelter. In contrast, Western Anatolia has a longer grazing period (about 210-230 days), meadow areas are very limited and meadow hay are not used while the animals stay in the shelter (Figure 3).

Rangelands are suitable for grazing from May to the beginning of November in the Eastern Anatolia Region, and produce green fodder for about 2 months from May to July and for 1 month in autumn. These grazing areas are the good alternatives for organic animal husbandry where there is a shrub cover in the dry summer season. (Figure 3). Shrublands offer sufficient and quality forage for animals to browse year-round in Western and Southern Anatolia, but they cannot produce forage during harsh winters in Central and Eastern Anatolia Regions, and also it is difficult for animals to take benefit from these areas due to their unfavorable weather conditions.

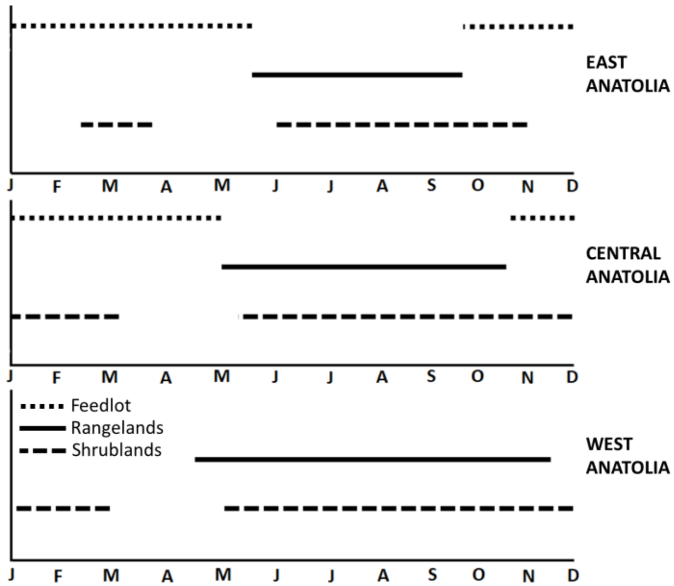

Figure 3. Year-round Use of Meadows, Rangelands and Shrublands by Livestock in the Eastern, Central and Western Anatolian Regions of Turkey. Meadows are not used as Feedlots in Western Anatolia because of Its Very Limited Areas. Shrublands Produce Fodder for Animals in Summer, Fall and Winter. But, Animals cannot take Benefit from These Areas in Eastern Anatolia Because of Its Harsh Winter.

The most important problem here is that the grazing, especially in rangelands, is not done in accordance with management principles. Particularly, the small ruminants stay in rangelands throughout the year as there the weather conditions are suitable (Gökkuş, 2020). Grazing causes serious damage to plants with lack of adequate photosynthetic tissues, and are easily affected by unfavorable environmental factors when the growth totally stops or limited growth is seen in plants. Early grazing causes heavy grazing (Savory, 1988). In addition, there are animals above the carrying capacity of rangelands in certain residential areas. Heavy grazing also does not allow the plants (especially, climax plant species) to renew themselves. Moreover, in grazing when wet; the soil is compacted and its structure is deteriorated, root development is weakened, organic matter is reduced, the penetration of rain water into the soil is limited, and surface runoff and erosion increase accordingly (Bilotta et al., 2007; Drewry et al., 2008). As a result of such misuse, plants being directly affected as well as the soil structure deteriorated, ultimately reducing the forage production and quality of rangelands. This may result in grazing animals making less use of the produced biomass, to spend more time in grazing, to decrease the conversion rate of the consumed feed into animal products, the occurrence of poisoning from time to time due to the poisonous plants, deterioration of the quality of animal products with the increase of fragrant, thorny and hard structured plants, and adverse effects such as injuries to animals. The need for veterinary services increases depending on the health problems of animals. Degradation of vegetation also makes rangelands improvement necessary. Chemicals such as fertilizers and herbicides may be required in rangelands improvement. The proper usage of rangelands is indispensable both for conventional as well as for organic rangeland livestock raising to eliminate this drawback (Altın et al., 2011b; Holechek et al., 2011).

Shrublands can be browsed throughout the year. But this practice should not be in the form of continuous browsing, particularly, it should not be grazed in spring. Shrubs should be allowed to grow at least 2 meters of heights in areas with tall shrub species (maquis formation), because goats can stand up on two feet and rise up to a height of 1.8 meters (Altın et al., 2011b). Even if the lower branches and leaves are browsed thus, they will be able to survive because the upper parts will not be browsed.

Forage produced from meadows is mostly harvested, dried and then stored for future usage. These forages are an important source of roughage while the animals are in shelter. However, meadow grasses cannot completely meet the forage needs of animals during their non-rangeland period. Because of this reason, organic fodder crops must be produced in order to provide adequate roughage in organic livestock farming based on rangelands. It may be possible to produce more efficient and quality forage especially, growing leguminous and gramineous fodder crops together without using fertilizer (Miller, 1984). For instance, the amount of forage, produced from the mixture of smooth bromegrass along with the leguminous crops such as alfalfa and red clover, was equivalent to 150 kg/ha N of smooth bromegrass while sown as single crop (Gökkuş et al., 1999).

8. CONCLUSION AND RECOMMENDATIONS

In Turkey, animal husbandry is an unregistered organic livestock farming since no chemicals are used for the development and maintenance of rangelands, shrublands and bushes. It is possible to certify the production of organic livestock easily by taking account some precautionary measures. These are: (a) principles in terms of the proper usage of rangelands should be observed, (b) shelters should be built in accordance with animal welfare, there should not be a source of disease, and (c) organic fodder crops should be produced for roughage and concentrated forage purposes.

Vegetation cover and land structures of the regions show different characteristics. Because of this reason, regions should have different preferences in terms of organic livestock farming. For instance, herbaceous rangelands are common in Eastern and Central Anatolian Regions while the rangelands dominant with bushes are mostly found in Aegean and Mediterranean Regions. The relatively slightly wavy parts of the Eastern Anatolian plateau are suitable for cattle breeding while its hilly parts are very suitable for sheep breeding (Gökkuş & Koç, 2010). Central and Southeastern Anatolia Regions have a good potential in terms of sheep breeding. On the other hand, the Mediterranean belt has an important place, especially in goats grazing. Despite this general classification, rangeland sections suitable for cattle, sheep or goat grazing can be found in every region. Selecting and grazing animals in accordance with the characteristics of these natural grazing areas will pave the way for more efficient usage of vegetation and, as a result, more profitable organic livestock.

In organic livestock breeding, hybrid breeds that are native or adapted to rangelands are preferred (Çakmakçı & Erdoğan, 2012). Our sheep and goat species generally consist of native breeds. On the other hand, in Eastern and Central Anatolian Regions, mostly the cattle are consisted of hybrid (especially, the Montofon hybrid) or native breeds. Because of this, in terms of animal breeds, these regions are very suitable for organic livestock breeding. However, the production of organic fodder crops gains more importance in these regions due to the long winter season.

The annual roughage needs of rangeland animals should be well planned by considering the available resources. In the rangelands of Turkey, where cool climatic conditions are common, the herbaceous vegetation dries up in summer and loses its nutritional values to a large extent. Additional feed is inevitable during this season. Roughage should be given up to about half of the animals' daily roughage needs, depending on the feed situation of rangelands. It must be paid attention to include legumes and grains together or in appropriate crop rotation in organic roughage production in order to keep high the yield and quality of hay.

Consequently, for organic animal raising, Eastern Anatolia Region has great potential for cattle, Central and Southeastern Anatolia Regions for sheep and Mediterranean belt is for goat breeding. There are different grazing areas which are suitable for all breeds of livestock animals in Black Sea and Marmara Regions. The production of organic animals, in rangelands, can be done easily by taking account the simple measures along with the available and sufficient organic fodder crops, and there is a good potential in this regard.

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CHAPTER 11

ORGANIC FORAGE CROPS CULTIVATION FOR ORGANIC LIVESTOCK FARMING

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INTRODUCTION

Organic farming is an agricultural model that is based on sustainable production without using pesticides, chemical fertilizers, and growth hormones, that does not harm the environment and human health, and that is made under control, from production to consumption, by using natural resources (Ok, 2019). With the importance is given to healthy food, healthy environment, and animal welfare, the interest in organic agriculture in the world is increasing from year to year. As a result of the increasing interest in organic agriculture, as of 2019, organic agriculture is carried out in 187 countries in the world, with at least 3.1 million producers and on 72.3 million hectares of land, including in-conversion areas according to FiBL survey 2021, based on national data sources, data from certifiers, and IFOAM-Organics International (Willer et al., 2021). Moreover, when compared to animal numbers between 2010 and 2019 in Europe, there was an increase 80.9% in number of bovine animals and 55.3% in number of sheeps from 2010 to 2019, and the number of organic bovine animals reached 5 079 962 and the number of organic sheeps reached 5 413 520 according to FiBL survey 2021 based on Eurostat and national data sources (Travnicek et al., 2021).

The increase in the number of animals in organic livestock breeding brings out the need for organic feed. Accordingly, it is very important to meet the need for organic feed, which is the most important input of organic livestock (Yolcu & Tan, 2008). The fact that feed costs constitute approximately 70% of the basic inputs in livestock enterprises (Guven & Yavuz, 2020) shows the importance of this requirement.

Animal feeding in organic livestock farming differs from conventional farming in many ways.

Feed supply and animal feeding rules in organic livestock farming are given below (Anonymous, 2010).

1) *Apart from pet animals and fur animals, in organic animal breeding, animals are fed with organically produced roughage and concentrated feeds.*
2) *While their needs are met in organic nutrition at different developmental stages, quality production is ensured as well as production increase. Force-feeding of animals is prohibited.*
3) *When the transhumance time; The amount of feed eaten by animals grazing in non-organic areas cannot exceed 10% of the annual feed ratio while going from one grazing area to another. This ratio is calculated as the dry matter percentage of feeds of agricultural origin. Except for the period when the animals are in the highland every year, at least 60% of the feed is provided from the farm. If this is not possible, the missing part of the feed is obtained from other businesses that implement the provisions of the Organic Agriculture Regulation. At least 20% of the feed for pigs and poultry supply from the farm itself. If this is not possible, the missing part of the feed is supplied from other businesses or feed businesses that implement the provisions of the Organic Agriculture Regulation.*

4) *On average, up to 30% of the ration dry matter may contain substances of the conversion period. This rate can be increased up to 60% if the feed materials in the conversion period are getting from the same organic farm where the organic animals are breeding.*
5) *At different times of the year, breeding system allows animals to reach pastures. In ruminant rations; roughage such as silage and fresh hay should be at a minimum 60% in the dry matter of the ration. However, the authorized body may allow this rate to be reduced to 50% for up to 3 months at the beginning of lactation in organic animals breeding for milk production.*
6) *In case of a reduction in feed product amount due to natural disasters, the use of conventional feedstuffs in animal nutrition is allowed in the disaster area for a short time at the rate to be determined by the Ministry.*
7) *Roughage, fresh or hay, or silage are added to pig and poultry rations.*
8) *The following substances are used in animal feeding in organic livestock.*
    a) *Inorganic feed materials from plant or animal origin produced or prepared without the use of chemical solvents, or fermentation products getting from microorganisms whose cells were inactivated or killed (Saccharomycescerevisiae ve Saccharomycescarlsbergiensis).*
    b) *The use of spices, medicinal and aromatic plants, and molasses produced without the use of chemical solvents and not*

available in organic forms is limited to 1% for each species, the ratio of dry matter of feed from agricultural origin is calculated as annually,

c) Organic feeds supplied from animal origin,

d) The following mineral source feed matters (Table 1),

Table 1. Mineral Origin Feed Matters (Anonymous, 2010)

Calcareous seashells	*Fluorine-removed mono calcium phosphate*	*Magnesium carbonate*	*Sodium chloride*
Coral-like red algae	*Fluorine removed di calcium phosphate*	*Calcium magnesium phosphate*	*Sodium bicarbonate*
Lithotamn	*Magnesium oxide (anhydrous magnesium)*	*Magnesium phosphate*	*Sodium carbonate*
Calcium gluconate	*Magnesium sulfate*	*Monosodium phosphate*	*Sodium sulfate*
Calcium carbonate	*Magnesium chloride*	*Calcium sodium phosphate*	*Potassium chloride*

e) Sea salt, salt as coarse rock salt,

9) Antibiotics, coccidiostatics, medicinal products and other substances that increase growth or production cannot be used in animal nutrition.

10) Feeds, feed additives, feed processing aids, and animal feeding products; cannot be produced by using genetically modified organisms (GMOs) or products obtained from them.

11) The requirements for organically produced or processed feeds are as follows:

a) Conventional feed and organic feed cannot be processed in the same line in the same factory.

b) The substances in the composition of the products or any other substance used in the preparation of these products must not have undergone ionizing radiation-irradiation applications.

c) Organic feeds must be labeled. On the label; The organic amount of the feed is indicated over from the dry matter. The percentage of feed material acquired by the organic production method is remarked. The percentage of feed materials getting from conversion period products is shown. The total percentage of feeds from the agricultural origin is indicated. There is found the name of the authorized body.

d) Organically produced feeds and conventionally produced feeds are physically kept and stored in separate places.

e) The equipment used in organic feed preparation is separated from all kinds of equipment used in conventional feed preparation.

f) In conventional feed preparation units, both conventional and organic feed cannot be prepared in the same line. However, organic feed is prepared in conventional feed preparation units, provided that the feed preparation unit is cleaned with the substances given below before starting feed preparation in the feed preparation unit. The materials to be used in cleaning of the feed preparation unit are given below.

- Potassium and sodium soap

- Water and steam

- Lime cream

- Lime

- Quicklime

- Sodium hypochlorite (ex: bleach)

- Caustic soda

-Caustic potash

- Hydrogen peroxide

- Natural plant extracts

- Citric, peracetic acid, formic, lactic, oxalic and acetic acid

- Alcohol

- Nitric acid (for dairy production equipment)

- Phosphoric acid (for dairy production equipment)

- Formaldehyde

- Milking equipment and products used in disinfection and teat cleaning

- Sodium carbonate

12) Organically produced feeds or products obtained from them can be transported together with conventionally produced feeds in a way that does not cause mixing and contamination. The vehicles to which the bait will be transported are cleaned with the substances specified in the previous article. It is required that the amount of product during transport and the amount of product in delivery must be recorded.

13) Except for the addition of natural flavors in the processing or storage of organic feed, substances and techniques reformating again lost features, correcting the consequences of negligence during the procedure or that may cause misconceptions about the true nature of these products are not used.

Organic grasslands constitute the majority of the organic roughage resources available in the world. As of 2019, more than two-thirds of the existing organic agricultural lands in the world consist of grassland/grazing areas (approximately 49 million hectares) (Willer et al., 2021). However, roughage obtained from organic grassland/grazing areas in many countries is not sufficient for the nutrition of organic animals. This situation makes growing organic forage crops a necessity for many countries.

In the production of organic forage crops, as in other crop production, there may be some decrease in yield compared to conventional production. de Ponti et al. (2012) stated that the yield difference in organic and non-organic crops varies considerably amongst crop groups and regions, and the organic yields of individual crops are on a mean 20% less than non-organic yields. However, it was stated that the management practices in organic farming have completely different effects on the yield gap between organic and conventional agriculture (Ponisio et al., 2015) and the yield comes to close the conventional yield after 10-13 years as a result of different management practices in organic agriculture (Schrama et al., 2018). In this respect, making scientific studies on the determination of ideal management methods in organic forage crops cultivation (Temel et al., 2013) and putting them into practice (Acikgoz et al., 2010; Yolcu et al., 2013; Yolcu et al., 2014) is very important. The ideal management techniques and methods obtained as a result of these studies can decrease the yield gap between organic and non-organic forage crops and make a significant contribution to meeting the feed requirement of increasing organic animal numbers.

For this reason, this section was included the information obtained as a result of scientific studies about basic forage crops management techniques, organic forage crops, and other products, and some of the provisions of the organic agriculture regulation regarding organic plant production and animal nutrition. It was aimed to reveal the management and techniques of organic forage plants based on the information obtained.

1. ORGANIC FORAGE CROPS CULTIVATION

Alfalfa, sainfoin, vetches, clover, grasses, bromegrass, wheatgrasses, fescues, silage maize and sorghums are the main products that are likely to be grown as organic forage crops in many countries.

The production of organic forage crops starts after the conversion period. It is required at least two year conversions period before being used as feed for grassland and forage crops used organically (Anonymous, 2010). After the conversion process is completed, the cultivation of organic forage plants is started.

Seed choosing, soil preparation, sowing, organic fertilization, irrigation, struggle weeds, diseases and pests, harvest, and storage are the issues that should be emphasized in the production of organic forage crops (Yolcu et al., 2013). The periods of cultivation and management in the production of organic forage crops are discussed under separate titles below.

1.1. Seed, Seed Bed Preparation and Sowing in Organic Forage Cultivation

Seed, seedbed preparation and sowing are issues that need to be handled carefully for succesfull production in organic forage crops cultivation. *Seed; It must not be genetically altered, the DNA sequence in the fertilized cell nucleus should have not been tampered with, it must not have been treated with synthetic pesticides, radiation, or microwaves, and must be produced in accordance with the provisions of the regulation. (Anonymous, 2010). In cases where it is not possible to obtain the seed from an organic or conversion production unit; the use of conventional seed is allowed by recording the amount of seed allowed with a one-time and one-season permit before sowing (Anonymous, 2010). In addition, GMO seeds cannot be used in the cultivation of organic forage crops (Anonymous, 2010).* The germination rate and purity of the seeds to be used in the cultivation of organic forage plants should be high. All kinds of weed seeds, diseases, and pests free of high-quality seeds should be used. Because contaminated seeds make the struggle more difficult to against weeds, diseases, and pests.

In organic agriculture, it is essential to protect and develop biodiversity, and to prevent soil erosion and compaction (Anonymous, 2010), for this reason, it is decided whether adequate soil protection measures have been taken in the land, and tillage that will cause erosion in the soil and unnecessary is not done (Anonymous, 2010).

Reduced tillage in organic agriculture encourages worm communities (Moos et al., 2016), and it increases microbial biomass, the change and activity in microbial communities, and topsoil organic carbon (Krauss et al., 2020) and also reduces erosion (Seitz et al., 2019). Moreover, reduced tillage is effectively increasing soil fertility indicators in organic agriculture (Gadermaier et al., 2012).

Reduced tillage had a favourable effect on crop performance in the short and long term in organic agriculture (Krauss et al., 2010). Krauss et al. (2010) reported that due to dry situation, grass-clover had 25% higher yields in reduced tillage than in non-organic tillage, pointing to better water-holding of reduced tillage soils. Moreover, silage maize had 34% higher yields in reduced tillage than conventional tillage, in spite of two to three times more but still tolerable weed invasion (Krauss et al., 2010). Furthermore, reduced tillage caused also higher mineral contents of the forage mixture (Krauss et al., 2010). Besides, reduced tillage in organic farming has many advantages, including a reduction of energy and labor input (Moos et al., 2016). Organic plant management and reduced tillage can be thought together to improve soil structure (Loaiza Puerta et al., 2018) and crop yield, quality of crop and costs of production. It is therefore important to be promoted holistically because of the collective effects of reduced tillage and various ley-based crop rotations and an organic agriculture system with organic fertilization (Gadermaier et al., 2012).

The seed of organic forage plants may have some problems in their emergence and early stages of their growth in especially negative climatic and soil conditions, due to generally the small size of their seeds and the weak seedlings (Acikgoz, 2001). To overcome these problems, it is very important to use high-quality seeds and to prepare clean and good seedbeds without weeds, diseases, and pest factors. Besides, soils should have sufficient moisture, and seeds should contact the soil effectively.

For successful cultivation of organic forage plants, sowing should be done at the proper sowing time, the sowing depth, sowing dose, and row spacing according to obtained results from scientific studies for each region. However, seeds should be sowed at a time when they can benefit most from the available rainfall. Cold-resistant varieties should be sowed in autumn in order to take full advantage of autumn precipitation, melting snow and spring precipitation. Varieties that cannot be sowed in autumn because they are not resistant to cold should be sowed as early as possible in the spring. Sowing depth may vary depending on soil conditions. However, in general, sowing should be done at a depth of 2-4 times the seed diameter (Acikgoz, 2001). Seeds should be sowed with forage seeders and the seeds should be contacted with the soil effectively. If sowing is done by scattering, a roller must be used to ensure the contact of the seeds with the soil.

1.2. Fertilization in Organic Forage Crops Cultivation

Protection and development of soil fertility and sustainability, and nutrition of plants through soil ecosystem in organic agriculture are essential (Anonymous, 2010).

The fertility and biological activity of the soil is provided by the methods mentioned below (Anonymous, 2010).

1) *Within the perennial crop rotation program, leguminous and deep-rooted plants are grown or green fertilization is done.*
2) *Animal manure or organic materials getting from organic production, preferably both are allowed to be used as composted. In order to prevent agricultural nitrogen from causing water pollution, the total amount of animal manure to be used in organic plant production cannot exceed 170 kg/N/ha/year. This limit only is applied in the use of composted farm manure and liquid animal manure including farm manure, dry farm manure, dried poultry manure, composted animal feces and poultry manure.*
3) *The use of biodynamic preparations is allowed.*
4) *Nitrogen fertilizers obtained by chemical methods cannot be used.*
5) *If sufficient soil fertility and biological activity cannot be achieved despite the above measures, Fertilizers, soil improvers, and nutrients to be used in organic agriculture are used. Fertilizers, soil improvers and nutrients (including seaweed production) to be used in organic farming are given below (Table 2).*

Table 2. Fertilizers, Soil Improvers and Nutrients (Including Seaweed Production) to be Used in Organic Farming (Anonymous, 2010)

Farm manure	*Main slag*
Dried farm manure and dehydrated poultry manure	*Crude potassium salts or kainite*
Composted animal feces containing poultry manure and farm manure	*Potassium sulfate containing magnesium salt*
Liquid animal feces	*Stillage and stillage extract*
Composted or fermented household waste mixes	*calcium carbonate (chalk, limy soil, limestone, breton ameliorant, (maerl), phosphate chalk)*
Peat	*Magnesium and calcium carbonate*
Cultured mushroom production waste	*Magnesium sulfate (kieserite)*
Worm (vermicompost) and insect feces	*Calcium chloride solution*
Guano	*Calcium sulfate (gypsum)*
A mixture of composted or fermented plant materials	*Industrial lime getting from sugar production*
Solid final product of the biogas production process containing ingested animal by-products together with plant or animal material	*Industrial lime getting from vacuum salt production*
Animal products and by-products: *Blood meal, hoof/nail meal, horn meal, bone meal or bone meal without gelatin, feather, hair and milled pelt/skin meal, fish meal, meat meal, wool, fur, hair, dairy products, hydrolyzed proteins*	*Elemental sulfur*
Plant origin product or by-products for fertilizers	*Trace elements*
Seaweed and seaweed products	*Sodium chloride*
Sawdust and wood pieces	*Coarsely ground rocks and clays*
Bark compost	*Leonardite (crude organic sediment rich in humic acid)*
Tree ash	*Chitin (polysaccharide obtained from the shell of crustaceans)*
Phosphate of soft rock	*Organic matter-rich sediment (for example, sapropel) formed in an oxygen-free environment in freshwater resources*
Aluminum calcium phosphate	

6) *For compost activation, non-genetically modified, appropriate plant-based preparations or microorganism preparations are used.*
7) *Non-genetically modified microorganism preparations allowed to be used to increase the usefulness of nutrients in plant or soil with soil conditions are used.*

In order to obtain high efficiency from the unit area and high quality in plant production, the nutrients needed for the plants must be readily available in the soil. If there are not enough nutrients in the soil, the missing minerals should be supplemented with organic fertilizers. Soil analysis should be done first for fertilization in organic forage crops cultivation. The nutritional elements required as a result of the analysis should be met from organic fertilizer sources. By analyzing the organic fertilizer sources, the amount of organic fertilizer needed for the cultivation of each organic forage plant should be determined as a result of the calculations and added to the soil. While meeting the need for nutrients from organic fertilizer sources, care should be taken not to adversely affect other properties of the soil, such as pH, lime, etc.

Meeting the nutrient needs in organic forage crops cultivation can be divided into main topics such as rotation, intercropping mixture, use of farm manure, use of compost and green manure, use of soil conditioners, use of microbial fertilizers (Yolcu et al., 2013; Temel et al., 2013), the use of vermicompost and the use of organic waste. Each main topic is discussed separately below.

a. Rotation to contribute the nutrient requirement

While forage crops make a positive contribution to rotation systems, they can also increase their own productivity and own quality in well-organized rotation systems. Soil quality can be provided in organic farming when periodic soil tillage and perennial forage crops are alternately included in the rotation (Schipanski et al., 2017). In a study, there were a ley period after a 4-year arable crop rotation and a ley period had positively effect in the soil structure in intensive tillage plots to the level of organic reduced tillage (Loaiza Puerta et al., 2018). The presence of more legumes in different rotation systems including legume forage plants, had a greater effect on the microbiotic properties of the soil (Ghimire et al., 2014). The addition of pasture to the rotation systems increased soil organic matter by 14%, carbon mineralization by 146%, extracellular enzyme activity by 35%, and it affected microbial biodiversity and nitrogen loss (Walkup et al., 2020).

In another study, a pasture and a rotation consisting of silage maize, forage rape, and a legume or maple pea were compared (Garcia et al., 2008). Rotation treatment had >42 t ha^{-1} year^{-1} dry matter yield per year on an average of the 3 years and the pasture treatment had >17 t ha-1 year^{-1} (Garcia et al., 2008). Rotation treatment had higher nitrogen and water-use efficiency than the pasture treatment, but quality of pasture was slightly better than the mean of the rotation treatment (Garcia et al., 2008).

Rotation of organic grass forage crops with legume forage crops and edible grain legumes may contribute to increasing hay yield and quality of organic grass forage crops. Because legume crops supply a high amount of nitrogen into the soil. Rotation of organic legume forage crops with other organic legumes may also contribute to meeting the nutrient requirement.

b. Intercropping mixture to contribute the nutrient requirement

Intercropping mixture is a common farming model in the production of organic forage crops (Yolcu et al., 2010a; Yolcu, 2015). In intercropping mixture, in general, leguminous forage crops and grass forage crops are grown together, and it is aimed that grasses benefit from the biological nitrogen produced by *Rhizobium* spp. bacteria, which is found in the roots area of legumes. Moreover, since the plants in the intercropping mixture have different morphological characteristics, it may be possible to use the plant growth resources in the soil and in the air effectively (Yolcu et al., 2010b). In addition, according to the establishing model of the intercropping mixture, the existing water and precipitation can be utilized better by the plants and erosion can be reduced by the intercropping mixture. Yield and quality contents of forages in intercropping mixtures and sole forages may differ according to species, climatic and soil conditions. In a study conducted under organic farming conditions, intercropping mixture enhanced forage yield by 72%, nitrogen yield by 190%, and crude protein content by 40 g kg^{-1}, compared to sole crop of cereals, but these advantages changed according to legume species. (Mariotti et al., 2006). In a meta-analysis study, intercropping mixture increased yields by 23% and gross income by 172 USD ha^{-1}, but effects varied importantly depending on management application and agro-ecological conditions (Himmelstein et al., 2017). The meta-analysis shows that intercropping is a sustainable advantageous practice, but its success depends on taking into account other factors, such as sufficient control of competition in the vegetation (Himmelstein et al., 2017).

c. Farm manure to meet the nutrient requirement

The nutrient requirement of organic forage crops is met by the use of farm manure, which is produced on-farm and has a low cost for farmers. According to Yolcu et al. (2010a), content of organic solid and liquid cattle manure separated from the separator in a two-year average is as follows (Table 3).

Table 3. Some Properties of Solid and Liquid Cattle Manures (Yolcu et al., 2010a)

Manure	pH	M	D	OM	N	P	K	Ca	Mg	Na	Fe	Zn
		%			ppm							
Solid	7.5	84.	15.5	25.2	3150	1900	115	3100	987	680	427	563
Liquid	6.8	-	-	-	5900	1000	455	150	88	67	39	37

M: Moisture, D: Dry Matter, OM: Organic Matter

Yolcu et al. (2010a) used 2 different organic solid and liquid cattle manure and 4 different combinations of them on common vetch and barley mixtures. As a result, they stated that common vetch and barley mixtures can be fertilized with 40 tons ha^{-1} solid cattle manure in terms of yield and quality (Yolcu et al., 2010a). In a two-year study, where there were organic and chemical fertilizer treatments, it was found that

20-ton ha^{-1} of solid cattle manure application had higher dry hay yield stem weight, plant height, crude protein content and crude protein yield than control in common vetch cultivation according to the results of the first year (Yolcu, 2011a). Yolcu et al. (2011a) stated that organic solid cattle manure had positive effect on the yield and quality and the macro (P, K, S, Ca, Mg and Na) and micro element content (Fe, Mn and B) of annual ryegrass. In the study conducted by Yolcu (2008), hay yield increased by 24% and dry leaf/stem ratio by 14.3% as a result of 20 tons ha^{-1} farmyard manure application to 2 barley and 1 wheat cultivars grown for roughage production.

In the study conducted by Yolcu (2015), 20 tons ha^{-1} of organic solid cattle manure application increased the dry matter yield by 23% in the second year of the research. It increased the crude protein rate by 20-23%, the crude protein yield by 32-51% and some mineral contents in both years in Hungarian vetch and barley intercropping (Yolcu, 2015).

Organic solid cattle manure in most cases positively affected the P, B, Cu, Fe, Mg and Na contents, and it did not affect on N and CP contents, but it reduced ADF, NDF, K, Ca, Mn and Zn content of winter cereal forages (Yolcu et al., 2016).

d. Compost to contribute the nutrient requirement

Compost fertilizers produced by the evaluation of organic wastes are widely used in plant production. Composting consists of natural bioseparation of organic waste with the participation of various types of microorganisms (Azim et al., 2018). Compost, which is used in the cultivation of many products, can also be used in the production of organic forage crops.

In a study, 50 t ha^{-1} greenwaste compost application caused 30.9 t ha^{-1} the additional fresh weight yield response of forage maize and a 75 % enhanced relative to the control over the three years of the experiment, and three year treatments of compost at 50 t ha^{-1} caused an important enhance in magnesium, extractable potassium and organic matter, and an important reduce in pH of the soil (Parkinson et al., 1999). Besides, Parkinson et al. (1999), stated that compost of mature green waste was not enough for the total fertilizer requirement for forage maize.

e. Green manure to contribute the nutrient requirement

Green manuring is the mixing of plants belonging to the legume family, which form abundant vegetative parts in a short time, into the soil in order to improve soil conditions (Acikgoz et al., 2010). Legume green manures are more effective than graminaceous green manures in terms of affecting positively soil conditions (Guo et al., 2018). With the cultivation of legumes as a green manure plant, plenty of nitrogen is released into the soil with both root nodules and above-ground parts of the plants (Acikgoz et al., 2010).

Green manure in organic forage crops is an important application to improve the soil nutrients and to develop soil conditions. Green manure application in the production of organic feed sources is mostly used in the cultivation of silage corn and sorghum. Annual legumes are mostly used as green manure before silage corn and sorghum.

In a study where *Vicia villosa* Roth., *Sesbania cannabina* Poir., *Melilotus officinalis* L., *Medicago sativa* L., *Vicia sativa* L. and *Lolium perenne* L. were used as green manure plants, parcels with the green manure application and the parcels without green manure were compared (Guo et al., 2018). Soil water content increased by 1% and 6.2% in the medium and subsequent growing periods of green manure, and the EC and soil pH decreased (Guo et al., 2018). Green manure caused the return of 15.6-195.4 kg N hm^{-2}, 5.3-58.8 kg P_2O_5 hm^{-2} and 34.5-127.9 kg K_2O hm^{-2} to soil (Guo et al., 2018). Green manure increased soil organic matter by 0.42-1.86 g kg^{-1}, total nitrogen by 0.05-0.34 g kg^{-1}, alkali-hydrolyzed nitrogen by 0.5-32.3 mg kg^{-1}, available phosphorus by 0.42-4.65 mg kg^{-1} and available potassium by 3.8-26.1 mg kg^{-1}, respectively in the 0-20 cm soil layer (Guo et al., 2018). It caused an increase in the yield by 1 294-19 391 kg hm^{-2} and in protein content 0.4-23.9 mg g^{-1} of silage maize (Guo et al., 2018).

The ability of cover crops as green manure is highly dependent on weather conditions, primarily precipitation (Cupina et al., 2017). Acikgoz (2001) stated that there is no positive effect of green manure in drylands.

Climate, plant species and soil conditions are the most important factors in the eventual success of green manure.

f. Soil conditioners to contribute the nutrient requirement

Soil conditioners in organic agriculture are used to enhance the fertility of the soil. In a study with common vetch, it was found that leonardite application increased dry matter yield compared to control (Gul et al., 2015). Leonardite application increased hay yield by 24%, crude protein ratio by 28%, crude protein yield by 58 %, P, K, S, Ca, Mg, Na, Fe, Mn, and B concentration, it had no effect Cu and Zn concentration of annual ryegrass (Yolcu et al., 2011a). In a study, leonardite applications in the first year of the study, positively affected the dry hay yield, crude protein, and crude protein yield of common vetch (Yolcu, 2011a).

g. Microbial fertilizers to contribute the nutrient requirement

The effects of plant growth-promoting rhizobacteria (PGPR) from different origins have been studied in many plants in many countries. Studies show that some PGPR has significant potential to contribute to the nutritional requirements of all plants. Some PGPR has the ability to supply the plant primarily by fixing nitrogen and dissolving available phosphorus in the soil, but their effectiveness may vary depending on the plant species, climate, and soil conditions.

In the Italian ryegrass plant, where different organic fertilizers are applied, RP24/3 PGPR caused an increase of 50.1% in yield and 68.3% in crude protein yield and it was determined that all bacterial treatments increased the crude protein ratio, and most bacterial treatments caused higher crude protein yield, P, S, Mg, Cu, Zn and Fe contents compared to the control (Yolcu et al., 2011b).

Some PGPR applications had positive effects on morphological properties, ADF, NDF and macro and micro elements in Hungarian vetch (Yolcu et al., 2012). All PGPR caused a similar or lower dry matter yield and crude protein rate, and all PGPR decreased crude protein yield in Hungarian vetch (Yolcu et al., 2012). In another study, it was determined that only one of the 12 different bacteria applied to the Hungarian vetch increased the hay yield and other bacteria applications had similar or lower yields compared to the control (Yolcu 2011b). In the study conducted in common vetch, it was observed that 10 different bacteria applications did not cause an increase in hay yield, but only a slight increase in plant length, leaves number, stem thickness, and stems number per meter (Yolcu 2011c). As a result, it was stated that PGPR applications may be more effective in grasses rather than legumes (Yolcu et al., 2013).

h. Vermicompost to contribute the nutrient requirement

In recent years, the use of vermicompost (worm manure) in organic agriculture has become widespread. Vermicompost is an organic fertilizer obtained by decomposing organic wastes and animal feces and passing them through the digestive system of worms. Vermicompost improves the soil structure and provides the soil with nutrients ready for the use of plants. Tobay and Tan (2019) found that vermicompost application significantly increased the yield of silage maize. In another study, it was determined that vermicompost applications increased forage dry matter, protein ratio and plant height of maize (Niazi et al., 2017). But the use of vermicompost in organic forage plants does not seem economical yet nowadays. With the reduction of production costs, its use in organic forage crops can become widespread.

i. Organic wastes to contribute the nutrient requirement

In organic farming, some organic wastes can be used as a source of nutrients in organic agriculture. In a study, sheep manure, wool manure (mixing of waste wool, sheep manure, crop residues), waste wool 1 (consisting of impurities and dirty just after shearing), and waste wool 2 (the part after removal of impurities) as organic fertilizer sources were applied in barley forage production (Lal et al., 2020). Wool waste improved the fertility of the soil, the physical properties of the soil, and resulted in higher water use efficiency and increased organic carbon by 30.8% and nitrogen by 32.6% (Lal et al., 2020). It was stated that the waste wool application caused 50% higher yield of grain and the dry fodder of barley as well as improving soil health (Lal et al., 2020).

1.3. Irrigation in Organic Forage Cultivation

Irrigation rules in organic plant production are given below (Anonymous, 2010).

a) Industrial and city waste water and drainage water obtained from the drainage system cannot be used in organic agriculture, when necessary, the suitability of the water is decided during the controls to be made by the authorized institution.

b) Irrigation water should not cause environmental pollution.

c) Irrigation should not cause deterioration of soil structure and erosion.

Among the organic forage crops, alfalfa, red clover, white clover, bromegrass, meadow fescue, and silage corn respond very well to the irrigation. In the production of organic forage crops, irrigation regimes may vary according to climate, plant, available usable water and soil conditions. Irrigation should be carried out in the light of scientific studies for each region. Irrigation should prevent waste of water and increase the use of effectively available water for organic forage cultivation.

1.4. Plant Protection in Organic Forage Cultivation

Plant protection rules in organic production are given below (Anonymous, 2010).

a) The following points are taken into account in the control of diseases, pests, and weeds.

1) Species and cultivars resistant to diseases and pests are selected.

2) Appropriate crop rotation is prepared.

3) Appropriate tillage methods are applied.

4) Cultural, biological, and biotechnical control methods are applied.

b) In case the above-mentioned issues cannot be applied or are insufficient against plant diseases, pests, nematodes, and weeds, the following plant protection substances are used (Table 4).

Table 4. Plant Protection Substances (Anonymous, 2010)

1- Herbal or Animal Substances

Azadirachtin extracted from Azadirachta indica (neem tree-false rosary tree)	*Plant oils*
Basis substances	*Pyrethrins extracted from Chrysanthemum cinerariaefolium*
Wax	*Prethyroids (only deltamethrin or lambdacyhalothrin)*
Hydrolyzed proteins other than gelatin	*Quassia extracted from quassia amara*
Laminarin	*Repellents that have an odor effect originated plant and animal/sheep fat*
Pheromones	

2. Microorganisms or Substances Produced by Microorganisms

Microorganisms	*Spinosad*

c) For the products used for traps and spreaders, except for the pheromone emitters, the traps and/or emitters shall be in such a way as to prevent the release of these substances into nature and their contact with the grown product. Traps are collected and destroyed after use.

Weeds are a major problem in the production of organic forage crops cultivation. In the production of perennial organic forage crops, weeds can cause a serious problem since organic forage crops cannot develop strongly in the first year of production. In silage maize cultivation, large row spacing and interrow spacing and rich soils in terms of nutrients may cause an increase in the rate of weeds. Since forage crops have a great diversity of species and varieties, there are many diseases, insect and harmful factors affecting these crops. Some diseases in moist and irrigated conditions and some insects in dry periods can be harmful for organic crops cultivation. Diseases and pests are more common in legume forage crops. However, since the wildness characteristics of many forage crops still continue, these plants are relatively resistant to diseases and pests compared to many other field crops. *Common diseases and pests seen in forage crops can be listed as follows (Tan, 2018).*

<u>Leaf Diseases</u>: Erysiphe graminis, Pseudomonas andropogani, Helminthosporium bromi, Leptosphaerulina trifolii, Colletotrichum villosum, Septoria pisi, Puccinia sp.
<u>Stem Diseases:</u> Colletotrichum trifolii, Kabatiella caulivora
Phoma sp., Mycosphaerella sp., Ascochyta sp.
<u>Root and Crown Rots Disease:</u> Phytium sp., Helminthosporium sp., Fusarium sp., Rhizoctania sp., Phytophthora catorum. Sclerotinia trifoliorum
<u>Flower and Seed Diseases:</u> Claviceps purpurea, Phialea tumelenta, Ustilago sp., Sorosporium sp., Sphocelotheca sp.
<u>Viruses:</u> Alfalfa mosaic virus
<u>Nematodes:</u> Dictylenchus dipsaci
<u>Grass-Eating Insects:</u> Hypera postica (H. variabilis), Colias eurytheme, Caenurgina erechtea, Plathypena seabra, Melanoplus sanguinipes, M. bivittatus, M. differentialis
<u>Sucking Insects:</u> Empoasca fabae, Therioaphis sp., Acyrthosiphon pisum, A. Kondoi, Tetranychus sp.
<u>Root-Eating Insects:</u> Sphenoptera carceli, Dipsosphecia scopigera, Sitona sp.

Seed Beetles: *Bruchus sp., Lygus sp., Adelphocoris sp.*

The following methods can be used in struggle against weeds, diseases, and pests in the production of organic forage crops.

a. Rotation for plant protection

Rotation in the production of organic forage crops can contribute to the reduction of weeds, diseases, and pests. One of the two purposes of crop rotation is the management of weeds, pests, diseases, and especially soil-borne diseases (Leoni et al., 2017). Weeds are the biggest barrier to getting high yield and quality crop production in organic agriculture, and farmers can decrease weed management inputs by planning rotations to affect negatively the weed community dynamics (Anderson, 2010). Weeds are less of a problem when forage crops are sowed in fields where cereal or hoe crops grew as a previous crop (Onal Ascı & Acar, 2019). In a study, a 9-year rotation consisting of perennial roughages and annual crops was proposed to affect negatively the growth of the weed community and decrease weed density in organic agriculture (Anderson, 2010). Weed management and protection of beneficial insects and profitability in organic systems can be maintained when regular tillage is alternately combined with perennial forage crops in rotation (Schipanski et al., 2017).

b. Using of seeds resistant to weeds, diseases and pests for plant protection

Organic seeds to be used in the cultivation of organic forage plants should be strong in terms of development, struggling weeds, and resistant to diseases and pests. In recent years, important studies have been carried out to develop organic seeds in the World. In these studies, efforts should be made to obtain seeds that are effective against weeds, diseases and pests, as well as high yield and quality.

c. Intercropping mixture for plant protection

Intercropping mixture can contribute to the reduction of weeds, diseases, and pests. For example, in the cultivation of alfalfa, which is a perennial forage legume plant, weeds can cause serious problems because the alfalfa doest not develop well in the first year. Sowing alfalfa as a companion plant with annual grains such as barley, wheat, oats, and rye in the first year can reduce the rate of weeds. Tan & Serin (2004) reported that the rate of weeds in alfalfa could decrease from 70% to 1% with companion plant application.

Intercropping mixture decreased disease in 73% of over 200 studies comparing diseases primarily caused by foliar fungi (Boudreau, 2013). Intercropping mixture affects diseases dynamics such as wind, rain, change of vector distribution, microclimate change, heat and humidity of weather, changes in the situation of the host, and direct inhibition of pathogen (Boudreau, 2013).

Intercropping mixture is a significant agricultural application that increases the diversity of the ecosystem and decreases pests (Rao et al., 2012).

d. Cuttings for plant protection

In organic forage crops cultivation, cuttings against weeds, diseases, and pests at the appropriate times is a common and effective control method (Acikgoz et al., 2010). To be cut plants at appropriate periods or growth stages in forage crops cultivation is one of the practices to prevent many weed problems (Green and Legleiter, 2018).

1.5. Harvest in Organic Forage Cultivation

Harvest rules in organic plant production are given below (Anonymous, 2010).

a) The technical tools and material used in the harvest of organic products should not cause ecological destruction and pollution.

b) Hand-picking equipments should be in a structure that will not spoil the organicness of the product. Harvest equipments must be hygienic.

c) Entrepreneurs take the necessary precautions against possible mixing and changes with conventional products and they can harvest organic and non-organic products at the same time if they ensure that organic products are identified.

ç) The following points should be considered in the collection of naturally grown edible plants and parts in forests, natural areas, and agricultural areas.

1) *The collection area should not have been treated with products other than fertilizers, soil improvers, nutrients, and plant protection agents to be used in organic agriculture until three years before collection process.*
2) *The picking area must not have suffered a fire in the last two years.*
3) *It is ensured the balance of natural life and protection of species in the picking area.*
4) *There is no conversion period for products collected from nature.*

It is very important to harvest at appropriate times in order to obtain ideal products in terms of yield and quality in organic forage crops cultivation. In addition, harvests should be adjusted according to the aim of use of the forage source. Since perennial forages stay in the field for a long time, harvesting methods that will shorten the economic life of these plants should be avoided. Alfalfa, sainfoin, vetches, clovers, grasses, bromegrass, wheatgrasses, fescues, silage maize, sorghums and other forage crops should be harvested in the light of the results obtained from scientific studies about harvest time so far.

Substances that can be used for different purposes in organic agriculture: *Other than the substances we have mentioned before; some other substances can be used in organic agriculture. These are given below. (Anonymous, 2010; Table 5).*

Table 5. Some Other Substances can be Used in Organic Agriculture (Anonymous, 2010)

Aluminum silicate (Kaolin)	*Kieselgur (diatomaceous soil, pure)*
Calcium hydroxide	*Lime sulfur (calcium polysulfide)*
Carbon dioxide	*Paraffin oil*
Copper hydroxide, copper oxychloride, tribasic copper sulfate, copper oxide, copper compounds in burgundy slurry forms	*Potassium hydrogen carbonate (aka potassium bicarbonate)*
Ethylene	*Quartz sand*
Fatty acids	*Sulfur*
Iron phosphate (Iron (III) orthophosphate)	

2. CONCLUSION

One of the basic needs of organic animal production activities is organic forage. Economical and high-quality and sustainable organic forage supply is necessary for the successful execution of organic livestock activities, however, there are still some difficulties in organic forage crops cultivation. These difficulties will be overcome in the middle and long term with scientific researches on organic forage crops cultivation. Organic forage crops production activities will be carried out more successfully through the new management techniques of organic forage crops to be obtained from these studies.

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CHAPTER 12

NUTRITIONAL STRATEGIES IN ORGANIC LIVESTOCK FARMING

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INTRODUCTION

Agricultural production entered a different stage with the "green revolution" that started in Mexico in the 1940s and became widespread in the 1960s. Eco-friendly traditional farming practices have been gradually replaced by intensive (industrial) agriculture aiming higher yields and more profits. The recent increase in chemical fertilizers, pesticides, antibiotics, and hormone residues in conventional agricultural products has increased people's concerns about health. Productivity in conventional farming, which is only focused on increasing production, depends on the intensive use of chemicals. However, chemicals change the environment and ecological system and also adversely affect human health. All these constitute the main reasons why organic farming is an alternative to conventional farming.

Studies comparing different aspects of organic and conventional systems with the development of organic farming revealed that organic production methods had positive effects on the environment, biodiversity, soil quality, and animal welfare and reduced pesticide residues. Therefore, the objectives of environmental, social, and economic sustainability also constitute the basis of organic farming.

The labor requirement per unit product and the income risk per animal are lower, production per animal per time unit and reproduction numbers are higher, and the feed conversion ratio, land use, and microbiological contamination are lower in conventional systems compared to the organic systems. On the other hand, in the organic systems, the income per animal or full-time employee is higher, the adverse effect on biodiversity is less, antibiotic resistance against bacteria is lower, and the level of beneficial fatty acids in cow's milk is higher (van Wagenberg et al., 2017).

The feeds used in organic animal nutrition directly affects the quality of animal products. There are very significant differences between the product quality of animals fed with concentrate feeds and animals fed with fresh or dry roughage or grazing on pastures. Studies have revealed that animals fed with 100% organic certified forage produce milk and meat containing high levels of omega-3 polyunsaturated fatty acids (FAs) and conjugated linoleic acid (CLA), thus ensuring a significantly healthier fatty acid balance (Butler et al., 2011; Bhat, 2013; Benbrook et al., 2018; Butler et al., 2021). In other words, the ration that the animal is fed is one of the most important factors affecting the quality of the product obtained and consumer preferences. The most important reason underlying the success of the organic systems is that they are mainly based on pastures and feeds produced without the application of chemicals.

1. FEATURES OF ORGANIC FEEDS

Pollutants such as pesticide residues, agricultural and industrial chemicals, and heavy metals in animal feeds cause safety hazards in foods of animal origin. Mineral imbalances caused by excessive or unbalanced use of chemical fertilizers adversely affect the health of ruminants. In cattle, excessive nitrogen or potassium levels in the soil lead to a decreased magnesium ratio in the blood, which results in grass tetany and low reproductive performance. On the other hand, excess phosphorus in the soil is also related to copper deficiency (Williams et al., 2000).

It is thought that the risk of contamination with pesticide residues and other agricultural chemicals decreases in comparison with conventional farming methods since animals must be fed with organically produced feeds in the organic systems (Magkos et al., 2006). For example, crop rotation is applied instead of synthetic plant protection products for disease and pest control in the production of organic feeds. Animal manure or compost from plant wastes is used instead of chemical fertilizers in plant nutrition. Since they dissolve slowly, they provide nutrients to plants over a long period of time (Jacob, 2007). Therefore, the label "organic" on a product is an assurance that chemical fertilizers, pesticides, and hormones have not been used in the production process and the use of drugs has been limited (Prache et al., 2009).

The accumulation and increase of these toxic substances in the soil as a result of the uncontrolled use of chemical fertilizers and pesticides in conventional farming impair soil health and indirectly affect human health. Therefore, agricultural production focuses on more sustainable and environmentally friendly methods. Within this framework, green manures are among the most important manures used in organic farming. Green manuring is the process of mixing plants with the soil at the vegetative or flowering stage and helps to enhance the physical, chemical, and biological properties of the soil. Moreover, it preserves the nutrients in the soil and reduces the losses caused by erosion, washing, etc. Green manures, generally legumes provide higher amounts of nitrogen to the soil. Nitrogen obtained from green manures is superior than urea nitrogen in increasing the growth, development, and grain yield of plants. Although their efficiency is similar to that of mineral fertilizers, they also improve the soil structure, unlike mineral fertilizers that disrupt the soil conditions (Bista & Dahal, 2018). Perennial legumes such as lucerne transfer available additional nutrients (phosphorus, potassium, calcium) to the soil for succeeding crops with their deep root systems. Green manures are not rich in potassium and especially phosphorus, but they improve soil physical properties and stimulate microbial activity. After its decomposition, the renewal phosphorus and potassium in a scientific way enhances the organic farming pattern (Talgre et al., 2012).

The superiorities of organically grown feeds over conventional feeds can be summarized in the following way:

- Pesticide residues can be very high in conventional feeds due to the widespread use of pesticides, which is more common in roughage such as straw (Müller, 1980).
- High levels of heavy metals such as lead and cadmium were detected in different conventionally produced feeds (Aioanei et al., 2011).
- Organic feeds usually have higher vitamin C content and better protein quality than conventional feeds (Worthington, 1998).

- The phosphorus, magnesium, and iron contents of organic feeds are higher than those of conventional feeds (Ryan et al., 2004; Murphy et al., 2008).
- The protein content of conventional grain feeds is higher than that of organic grain feeds due to the use of mineral fertilizers in their production (Mäder et al., 2007; Tamm et al., 2009).
- Studies conducted to compare the impacts of organic and conventional feeds on animal health have demonstrated that organic feeds positively affect the health and performance of animals e.g., milk production in cows (Worthington, 1998; Galgano et al., 2016).

2. STRATEIGES OF ORGANIC LIVESTOCK NUTRITION

Feeding strategies in the organic systems should include the following in terms of animal welfare (Zollitsch et al., 2004):

- The nutritional needs of animals should be met in accordance with their level of production.
- The feedstuffs used in the ration should be suitable for animals' physiology.
- The appropriate feeding behavior of animals should be allowed; feedstuffs should be presented to animals with their natural structures, animal-friendly feeding techniques should be used, and a suitable environment for feed intake should be ensured.

- The values and goals specific to organic farming, such as environmentally friendly production methods, intact nutrient chain, and the limited use of non-renewable critical resources, should be achieved.
- Economic gain should be provided to farmers.

The nutritional requirements of organic livestock should be met with organic certified feeds. Moreover, roughages used as bedding should also be certified organic (Rinehart & Baier, 2011). Restricted and force feeding is forbidden in organic livestock farming. Certain feed additives, such as vitamins and trace minerals, that are not produced organically can be fed to organic livestock in trace amounts. Organic animal feeding is managed without antibiotics, added growth hormones, mammalian or poultry byproducts, or other prohibited feed ingredients (e.g., urea, manure, or arsenic compounds). Certain enzymes are permitted in the ration of organic cattle in addition to the feed not to stimulate growth unnaturally but to improve the utilization of nutrients (Blair, 2021).

The use of feeds and feed additives treated with chemical solvents and genetically modified organism (GMO) is prohibited in organic livestock farming. Mostly GMO corn and soybean are used in conventional livestock farming due to their being cheaper. Studies have revealed that there are GM DNA fragments in milk and meat products obtained from animals fed with GMO feeds (Mazza et al., 2005; Agodi et al., 2006).

Soil-based production is one of the basic principles of organic livestock farming (Chander et al., 2011). Thus, the pastures where animals are reared must also be certified organic and meet all organic crop production standards. Organic ruminants must have free access to pastures during the entire grazing season as climatic conditions allow. According to the National Organic Program (NOP), organic ruminants must graze on pasture during the grazing season of their geographic region, and this period must be at least 120 days. During the grazing season, animals must obtain an average of at least 30% of their dry matter intake from the pasture (Rinehart & Baier, 2011). In addition to feed supply, organic pastures contribute to keeping animals' immune systems strong owing to fresh air and daylight.

Organic small grain cereals (barley, oat, rye, triticale and wheat) may be pastured to extend the fall and spring grazing seasons. In addition, organic small grain pastures might be an alternative for alleviating early and year- round grazing pressure (McCartney et al., 2008), since the increased amount of manure in parallel to the increase in the number of animals should not cause nitrate pollution and the total stock density should not exceed 170 kg nitrogen/hectare per year in natural pastures in organic systems (Anonymous, 2010).

Image 1. Pastures are an important source of forage in organic livestock farming. (Photo by Hülya Hanoğlu Oral)

Image 2. Organic small grain pastures might be an alternative for alleviating early and year- round grazing pressure in organic systems (Photo by Hülya Hanoğlu Oral)

Approximately 80% of soybeans currently produced in the world are of transgenic origin (ISAAA, 2018). Especially solvent-extracted soybean meal is a commonly used protein source in conventional animal nutrition. Furthermore, since they are imported, there is a high risk of aflatoxin contamination during their transportation. In organic livestock farming, the use of industrially produced protein feeds based on oilseeds, i.e., soybean meal, is not allowed because of using chemical solvents for oil extraction. Hence, it is necessary to replace soybean meal in the ration with a safer, organic source of vegetable protein. Grain legumes of different species without these risks draw attention as alternative vegetable protein components of feedstuffs for livestock. Grain legumes represent a very important source of feed for organic farming since they can both meet the nutritional requirements of organic animals and maintain soil fertility (Sarhan, 2011). Various studies have demonstrated that the partial or complete replacement of soybean meal in the ration with alternative grain legumes such as chickpea, faba bean, and pea has no adverse impacts on animal growth or carcass and meat quality. Furthermore, when compared to soybean meal, both chickpea and pea affect the intramuscular fatty acids (FAs) composition by increasing the total amount of polyunsaturated n-3 FAs and thus ensure healthier properties of meat (Bonanno et al., 2012).

Although organic animals should be fed on feed materials produced in accordance with the rules of organic production, farmers should be also given the possibility to use in-conversion feed coming from their own holdings under certain conditions. Moreover, farmers should be allowed to use certain feed material of microbial and mineral origin or certain feed additives under well-defined conditions in order to provide for the basic nutritional requirements of animals.

In organic systems for herbivores, at least 60% of the dry matter in daily rations must consist of roughage such as fresh or dried fodder or silage (Jacobsen & Hermansen, 2001). Livestock farming should be associated with plant production. Thus, at least 60% of the feed should be obtained from the farm itself (Younie, 2001), while the remaining part should be obtained from other farms producing organic feeds or in-conversion production units in the same region (Anonymous, 2010).

Standards that regulate feeding management in organic systems are among the most critical factors that influence the yield and quality of milk. Organic regulations limit the use of concentrate feeds and reduce the variety of ingredients that can be added to the ration. This may cause energy, protein, and mineral (zinc, molybdenum, selenium, copper, and iodine) deficiencies, increasing the risk of nutrient imbalances. One of the major challenges in organic management is to formulate high forage rations with an adequate energy concentration due to the low energy value of most forages when compared to concentrate feed (Hernández et al., 2016).

Organic livestock farmers face many difficulties preventing and controlling diseases in farm animals and increasing production due to the prohibition of the use of chemical drugs and feed additives. Moreover, nutrition technologies are valuable to combat certain diseases and ailments and improve the health and welfare of animals. It has been found that a high amount of rumen undegradable dietary protein, minerals such as zinc, molybdenum, copper and phosphorus, and vitamins such as vitamins A, E and B_{12} are beneficial for ensuring resistance, resilience, and immunity against nematode infections. It has been determined that many minerals (iron, zinc, manganese, selenium, and copper), vitamins (carotenoids, vitamins E and C), probiotics and prebiotics are important for normal immune function and resistance to diseases in farm animals. Saponins, tannins, essential oils, and many other secondary plant metabolites appear as potential feed additives to increase organic animal production (Patra, 2007).

Many studies have shown that protein nutrition in the form of by-pass protein increases resistance against gastrointestinal parasites and strengthens the immune system. Resistance to *Haemonchus contortus* increased in sheep when rumen undegradable protein was given (van Houtert & Sykes, 1996; Coop & Kyriazakis, 2001).

Mineral deficiency is common in organic livestock due to the dependence of home-grown feeds and forages and mineral deficiency in pastures characteristic to a specific area. Zinc plays an important role to build up a successful immune response against gastrointestinal nematodes. Since iron loss occurs through blood during gastrointestinal parasitic infections, iron supplementation improves animal performance. Supplementation of molybdenum to the rations of sheep grazing on pastures with molybdenum deficiency reduces the worm burden. Copper has an anti-parasitic effect against some nematodes in sheep, goats, and poultry and increases immunity. Phosphorus supplementation in lamb rations reduces the number of parasitic larvae and eggs. On the other hand, it was stated that adult larvae and more parasite eggs were found in ruminants in vitamin A, B_{12} (or cobalt), E (or selenium) deficiencies (Patra, 2007).

3. ORGANIC CATTLE NUTRITION

The nutrition strategies of organic cattle feeding less with concentrate feeds in comparison with conventional systems contain significant differences. Organic cattle farming is based more on pastures and grazing areas than conventional farming, and the use of concentrate feeds and mineral supplementary feeds is more limited. In organic cattle systems, at least 60% of the dry matter in daily rations must consist of roughage such as fresh or dried fodder or silage (Jacobsen & Hermansen, 2001; Smigic et al., 2017). However, this rate is allowed to be reduced to 50% for a maximum of three months at the beginning of lactation (Harðarson, 2001).

In conventional cattle farming, high-yielding cows are mostly fed above their requirements using rations supplemented with high amounts of energy and protein concentrates. On the other hand, the objective of organic cattle farming is to use the available resources in the most appropriate way instead of maximizing production (Sorge et al., 2016).

Image 3. In organic cattle systems, at least 60% of the dry matter in daily rations must consist of roughage. (Photo by Hülya Hanoğlu Oral)

Image 4. Alfalfa hay is an important feed in organic farms since the forage is the main component of the ration (Photo by Hülya Hanoğlu Oral)

In organic cattle farming, newborn calves must be given colostrum for three days for the development of their immune system. The minimum period for which calves should be fed with milk is determined as three months (Asheim et al., 2016). Milk is a very suitable food for meeting the energy and protein requirements of young calves. On the other hand, for calves to get used to feed, good quality organic hay or concentrate feed should be placed in front of them from the second week. It is necessary to accustom calves to dry feeds at an early age for the development of the rumen and rumen's papillae, and the formation of the microbial population. This practice is also important for the healthy growth of animals that will be fed on roughage after weaning in the organic system.

3.1. Organic Dairy Cattle Nutrition

The energy requirements of high-yield dairy cows during the early lactation period are usually higher than the amount of energy intake (Hammon et al., 2009). High-energy concentrates are used to prevent the negative energy balance in conventional farming, but the energy shortage at early lactation can be more critical in grazing-based organic systems. Actually, an increased lipomobilization has been observed after calving in organic dairy cattle and the ratio of cows with subclinical ketosis is higher in organic farms (Abuelo et al., 2014).

The energy obtained from rations based on high-forage may be inadequate to meet the requirements of dairy cattle. Conventional farms are characterized by a higher total dry matter intake with a high proportion of concentrate feed, maize silage and forage silage. On the other hand, forage, pasture and high fiber intake are the most important variables in organic farming. Therefore, the rations used in organic farms have significantly higher acid detergent fiber (ADF) and lower organic matter (OM) content, which is why the rations have lower digestibility (Orjales et al., 2019).

In addition to the energy content of the rations, the other factors in balancing dairy cattle rations are protein content and protein use efficiency. Pasture generally contains more crude protein (CP) than other forages, even though it depends on the amount of nitrogen provided by fertilizers restricted in organic farming, as well as on the species grown (Hofstetter et al., 2014). For instance, pasture containing clover is rich in nitrogen, whereas the CP concentration of perennial ryegrass (*Lolium perenne*) is lower than that of leguminous species (van Vuuren & van Den Pol-Van Dasselaar, 2006). The growth stage of the plant and the leaf to stem ratio are important factors affecting protein content of pasture.

Protein in cattle rations is typically balanced using the metabolizable protein (MP) system. Metabolizable protein is the sum of the proteins supplied from different sources, and they consist of the protein from the feed, which escapes from microbial degradation in the rumen and is called the rumen undegradable protein (RUP), and the protein that is called microbial crude protein from microorganisms, passing through the rumen together with the digested protein. The part of the CP from the feed degraded by microorganisms is rumen degradable protein

(RDP), and it contributes to microbial protein synthesis. Protein requirement is affected by age and growth rate of animal. For example, younger or faster-growing animals need more MP than mature or slower-growing cattle. High-roughage rations do not meet the MP requirements of lightweight growing calves, especially when they graze or are fed with silage. Despite a high CP content of grazing roughage, most of it is degraded in the rumen at a high rate. Therefore, its RUP content is low. Lightweight calves are small enough that the microbial protein supply that washes out the rumen with ingesta may be insufficient to supply protein to support adequate gains. Additional RUP provided to meet the MP requirement may, in most cases, improve the performance of lightweight growing cattle. Due to the grazing requirement, calves reared in an organic production system may likely benefit from additional RUP (Schumacher et al., 2020).

When the energy obtained from fermentable OM is limited for ruminal microorganisms, not all of the nitrogen derived from degradable ration protein can be used for microbial protein synthesis. The excess nitrogen is excreted mainly as urinary urea and therefore, with these unbalanced rations, an increased excretion of nitrogen per unit of ration protein consumed by the animal is expected. In cyclical dairy systems (de Wit et al., 2016), when manure is used as fertilizer, nitrogen in feces is recycled at farm level, reducing environmental impact (Koesling et al., 2017). However, at the animal level, the use of unbalanced rations results in less ration nitrogen converted into milk protein (lower milk to feed protein ratio) and more nitrogen released into the environment. In order to increase the efficiency of protein use in organic farming and consequently to reduce nitrogen loss to the environment, the energy content of daily cattle rations should be increased by improving forage quality and formulating rations with more balanced forage and grain combinations (Orjales et al., 2019).

Including energy-rich crops such as fodder corn or fodder beet in the ration can provide energy-rich forage and improve the quality of the dairy cow ration. Furthermore, the quality of forage depends on the type of feed, herbage species, the development stage of the plant, and soil and climatic conditions. Although the age of forage is the most important factor (the fiber gradually becomes lignified, and the digestibility of the feed decreases), the methods used for the preservation of the forage also influence the quality of the feed. These factors are even more important in organic farms since the forage, which is the main component of the ration, must be of good quality to provide sufficient energy to the ration (Orjales et al., 2019).

In comparison with conventional production, organic milk production is characterized by a higher roughage/concentrate feed ratio. In a study carried out in Sweden, conventional cattle were fed with a limited amount of 1.5 kg of roughage per 100 kg of live weight per day, while organic cattle were fed *ad libitum*. Consequently, the roughage/concentrate feed ratio was 1.7 on organic farms and 0.7 on conventional farms (Fall et al., 2008).

Dry matter intake of lactating dairy cows depends majorly on the type of feeds supplied, the level of nutrition, ration formulation and feed quality (Mazumder & Kumagai, 2006). A recent study conducted in Switzerland has revealed that when the good quality roughage intake is increased and the proportion of concentrates in ration is decreased, dry matter, energy and protein intakes remain unaffected to a great extent (Leiber et al., 2015).

Productivity and feed-use efficiency in organic livestock farming are lower than in conventional livestock farming. Differences in feed-use efficiency are explained by differences in livestock system management (such as herd structure and slaughter age) in addition to feeding effects. Therefore, more space is needed in organic livestock farming than conventional livestock farming to achieve the same level of animal production (Gaudaré et al., 2021).

Dairy cow rations in organic livestock farming contain lower levels of feed supplements and vitamins as well as higher levels of roughage compared to conventional livestock farming. Relatively lower quality and/or limited rations increase the risk of metabolic diseases such as milk fever and ketosis caused by low calcium levels in the blood due to regular milking in organically raised high-yielding dairy cows (Sutherland et al., 2013).

3.2. Organic Beef Cattle Nutrition

The three systems used to produce beef are: Feedlot with total confinement; pasture feeding with some grain supplementation; and pasture feeding only. Although beef production systems vary considerably in practice, most cattle spend the majority of their lives on pastures and grazing areas. For example, cattle in the United States of America (USA) spend at least half of their lives on pastures, whether they are fed with grains or roughage. The pasture stage is almost universal, because cattle, as ruminants, have the ability to convert cellulose into meat. Other than nursing, almost all of the animal's initial weight gain is obtained from some form of forage, with roughages making up almost the whole ration fed to a beef calf before placing it in a feedlot. Grain-fed cattle require roughage in feedlot rations to maintain the health of their digestive systems (Mathews & Johnson, 2013).

Beef cattle spend most of their lives on grazing areas, and then grain finishing is implemented in feedlots. Therefore, the most significant difference between organic and conventional beef cattle feeding practices is during the finishing phase. In the USA, usually corn rations are used during the finishing phase in 80% of conventional beef cattle and 17% of certified organic beef cattle. All grains and conserved roughage consumed by certified organic ruminants must be 100% organic certified. Vitamins, trace minerals, and feed additives not produced organically are allowed to be used in trace amounts in the rations of organic farm animals if permitted by the organic regulations. On the other hand, the use of growth promoters such as ionophores and hormones and antimicrobials, which are commonly used in beef feedlot finishing, is prohibited in organic beef finishing (Hafla et al., 2013).

Grazing for cattle reduces foot and leg diseases that are common in confinement systems, but it also reduces meat production and exposes cows to parasites that can be difficult to treat without medication. Grazing reduces the use of environmentally and economically costly concentrate feeds and efficiently recycles nutrients into the soil, but it reduces cattle live weight gain (Hafla et al., 2013).

Organic beef cattle may still be finished in feedlots for no more than 120 days in the USA, but without growth hormones and antibiotics, gains may be reduced and illnesses increased (Hafla et al., 2013). On the other hand, the fact that feeding is predominantly grassland-based and there is more freedom of movement causes the meat color to be darker, the fat content in the meat to be low, and the flavor to decrease (Vestergaard et al., 2000).

In relation to feeding regimes, liver abscesses are more common in conventional calves than organic calves. Unlike intensive farms, the rations of organic farms contain lower levels of concentrate feed, which prevents rumen acidosis and liver disorders (Blanco-Penedo et al., 2012).

4. ORGANIC SHEEP AND GOAT NUTRITION

Sheep and goat farming is the main source of income for farmers who live in arid and semi-arid regions. These animals transform low-quality roughage into high-quality animal products with distinguished chemical composition and organoleptic properties. There is a wide range of sheep and goat breeding systems in the world, from highly extensive ones based on natural grasslands or rangelands to very intensive ones based on natural grazing and supplementary feeding (Zervas & Tsiplakou, 2011).

Small ruminants farming in the world is carried out based on rangelands, and the majority of the feed requirements of animals are provided from these areas. Therefore, there is no significant difference between organic and conventional systems in terms of sheep and goat feeding.

The ration of grazing small ruminants varies according to the season due to plant species suitable for grazing, the phenological stages of plants, climatic conditions, and feeding behaviors (Claps et al., 2020). However, sheep and goat nutrition in organic farming is mainly based on grazing on certified organic pastures and certified supplementary feeds (Ansari-Renani, 2016). Organic and conventional sheep and goat feeding systems show great similarity. Hence, there is no significant difference between the chemical composition of the milk obtained (Malissiova et al., 2015), meat yield, and carcass quality (Lu et al., 2010).

Native or local breeds genetically adapted to their environment are used in organic sheep farming. These breeds are more resistant to climatic stress and more resistant to local parasites and diseases, which allows them to use lower-quality feed (Hernández et al., 2016).

Forage-fed organic goat production can produce gains comparable to grain feeding in terms of cost per unit gain. A grass-fed organic goat will likely be leaner, have less saturated fat, more omega-3 fatty acid, more conjugated linoleic acid, and higher beta-carotene and vitamin E contents. All of these are attractive quality indicators for consumers. Hence, the increased costs of organic production can be balanced by higher product prices and healthier products than those produced conventionally (Lu et al., 2010).

In organic sheep and goat farming, the nutrition of the offspring is primarily provided by breast milk. If this is impossible, the offspring are fed with milk obtained from the same flock. The minimum period during which lambs and kids should be fed with milk is 45 days (Anonymous, 2010).

In many countries, nomad sheep and goat breeds convert vegetation in arid, mountainous, and biodiverse areas into a range of high-value organic foods. They do this without leaving any carbon footprints since they consume no energy for self-growing, harvesting, and transporting animal feeds (Ansari-Renani, 2016).

Image 5. Organic and conventional sheep and goat feeding systems show great similarity. (Photo by Hülya Hanoğlu Oral)

Image 6. Lambs and kids should be fed with breast milk for minimum 45 days in organic systems. (Photo by Hülya Hanoğlu Oral)

The feeding system that causes anemia in organic sheep and goats is prohibited and considered contrary to animal welfare. To avoid such problems, the utilization of pastures with herbaceous plants as well as grazing lands with trees and shrubs is included in feeding management practices. Especially the leaves of trees and shrubs rich in iron, sulfur, and copper can be used as supplements of herbaceous plants (Ansari-Renani, 2016).

Sheep and goats grazing on pasture are more susceptible to gastrointestinal parasitic infections than animals fed in the barn since they are exposed to fecal contamination. Studies have revealed that protein supplementation to grazing animals increases the resistance and resilience to parasites (Mendes et al., 2018).

Image 7. Native or local breeds used in organic sheep farming can use lower quality forage. (Photo by Selim Aksoy)

5. ORGANIC POULTRY NUTRITION

Organic regulations encourage housing conditions that meet the needs of animals and allow them to perform their natural behavior. To that end, it is taken into account that organic poultry, like all organic animals, should have access to open spaces and roughage. The purpose of providing free-range areas for poultry in the organic system is to improve environmental sustainability and animal welfare (Abdullah, 2018).

Cage breeding has adverse impacts on poultry, such as immobility, foot and leg disorders, cannibalism, and feather-pecking. Hence, it is forbidden to keep poultry in cages in the organic system. When climatic conditions allow, animals are allowed to reach outdoor shelters, which is applied in at least one-third of their lives. Outdoor shelters are mostly covered with vegetation, and animals are allowed to access a sufficient number of drinkers and feeders (Anonymous, 2010).

In the organic system, birds obtain some of their basic nutrient requirements by grazing from seeds, green herbs, legumes, grasses, and insects in the grazing area. However, since they cannot utilize cellulose, they cannot meet their nutrient requirements by utilizing only the grazing area. Grasses, legumes and turfgrass, as well as aromatic and native plants, are used in the arrangement of the grazing area. Legumes important in poultry production are soybeans and various field peas, as well as pasture forages like alfalfa, clovers, and vetches (Spencer, 2013).

Image 8. Providing poultry with an outdoor area gives them access to an extra source of feed (Photo by İbrahim Ak)

There should be a certain amount of roughage (fresh or dried fodder, or silage) in the daily ration of organically grown poultry. Silage as roughage can also help prevent feather-pecking and cannibalism in laying hens (Steenfeldt et al., 2007). Silage consumption increases with the age of poultry. Broilers can consume 10-20% of the daily dry matter during the growth period (weeks 1-4) and up to 30% during the finishing period (weeks 5-8). Thus, it is necessary to make an adjustment in the concentrate feed according to the increasing silage consumption at different stages of broilers' development. Silage consumption in laying hens can reach up to 20% of the total daily dry matter consumption (Crawley, 2015).

Feeds used in the nutrition of organic poultry must be organic and must not contain pesticides, synthetic fertilizers, antibiotics, coccidiostats, medicinal products, animal by-products, or GMO feed sources. At least 30% of the feed should be provided from the farm itself. If this is impossible, the missing part of the feed should be provided from other poultry or feed enterprises engaged in organic farming or in-conversion production units (Anonymous, 2010). The European Union postponed the transition to 100% organic feeding in poultry many times, and it is expected to enter into force from 2026. It is difficult to provide adequate levels of protein and essential amino acids when feeding poultry with 100% organic and locally produced feeds.

Amino acids (AA), the building blocks of proteins, are essential nutrients in the poultry nutrition. Methionine is an amino acid that should be obtained by poultry with the ration since it cannot be synthesized sufficiently by poultry. Nutrition with low levels of methionine leads to poor performance in poultry and increased immune system problems such as feather-pecking, cannibalism, and increased mortality (Sundrum, 2006). Corn, soybean meal, and other plant-based components used in poultry rations have low methionine levels. Therefore, when poultry are fed with corn and soybean meal-based rations, methionine is usually considered the first limiting AA for laying hens and the second limiting AA for broilers after lysine (Burley et al., 2016). When the protein ratio in the ration is increased, the amount of limiting methionine also increases, and excessive nitrogen excretion and environmental problems occur with manure. In methionine deficiency, the immune systems of animals weaken, and yield loss becomes inevitable. For organic farming to be able to compete with conventional farming, alternative natural feed sources that can substitute for synthetic methionine should be investigated.

As mentioned above, poultry need essential amino acids (especially lysine and methionine). Synthetic amino acids are added to feeds in conventional systems, but they are not allowed in organic systems. It is usually difficult and expensive to procure alternative products, such as natural essential compounds obtained from plant sources, which contribute most significantly to feed cost. In this context, the use of roughage in poultry feeding can be a sustainable and natural alternative for organic producers, especially under small-scale production system conditions. Moreover, the use of roughage as a local feed source is also important in facilitating the transition to 100% organic feed supply for organic poultry meat and egg producers (Tufarelli et al., 2018).

For poultry, the primary solution implemented to meet the needs of organic protein with optimal amino acid composition is the efficient use of both commonly used and new protein sources. Examples of commonly used and new protein sources are cereals, legumes, roughage and other green biomasses, marine feed sources and by-products. The secondary solution is to feed the animals less intensely and this strategy is more suitable for slowly growing breeds since they require less nutrients. To that end, solutions that combine regionally grown feed and slow-growing breeds with different feeding strategies should be considered. From an economic and environmental perspective, minimizing protein content in organic rations is crucial. Protein requirements depend on animal breed, season and production level, and the requirements of organic animals may differ from the known requirements of conventionally reared farm animals. (Nørgaaard et al., 2020).

The use of hormones as a feed stimulant and growth promoter in the poultry industry is prohibited. Hence, hormones cannot be used to increase growth in organic poultry production. Organic poultry producers must also avoid compounds or additives that contain antibiotics, such as non-organic chick starter. On the other hand, arsenic is used in some non-organic diets as a feed supplement and for protozoan parasite control. However, arsenic compounds must not be used in organic rations. The use of arsenic for the production of organic plants is prohibited. Therefore, poultry manure must not be applied to organic lands. Feed additives or supplements must not be used more than necessary to maintain health and ensure adequate nutrition in organic poultry production (Alagawany et al., 2018).

The use of probiotics, oligosaccharides (prebiotics), organic acids, enzymes, and plant extracts has gained currency in recent years, instead of antibiotics, whose use as feed additives is prohibited in animal nutrition. Probiotics that are biological products created from cultures of beneficial microorganisms regulate the balance of microflora in the digestive tract, prevent the production of pathogenic microorganisms, and thus increase feed-use efficiency. Enzymes and organic acids are obtained from probiotic bacteria or fungi. Enzymes increase the digestion of the feed, while organic acids reduce the intestinal pH and prevent the growth of pathogenic bacteria. Oligosaccharides are used to increase the growth of beneficial microorganisms in the digestive system and inhibit the growth of pathogenic microorganisms.

6. CONCLUSIONS

Animal nutrient requires long-term planning since it plays a key role in preventing infections, strengthening the immune system, maintaining health and enhancing production. Organic and biodegradable inputs from the ecosystem are used for nutrition, health, housing, and reproduction in organic livestock farming. The use of drugs, feed additives, and genetically modified synthetic inputs is deliberately avoided because the rations used in animal nutrition are among the most important factors affecting the quality of the product obtained and consumer preferences. The most important factor underlying the success of the organic systems is that it is mainly based on natural grazing areas and feeds produced without the application of chemicals. On the other hand, in the organic systems, animals are less dependent on feed sources that compete directly with food production since they are mostly fed in natural grazing areas.

Organic systems are becoming increasingly popular in many countries due to increasing consumer demand for organic products and environmental concerns. However, the conversion of conventional livestock farming to organic livestock farming is faced with various problems due to the lack of technical knowledge, insufficient organic feedstuff, unsatisfactory production of value-added products, and poor organization of farm and marketing management. Future research should be focused on the development of alternative feedstuffs and effective nutrition strategies to be used in organic livestock systems.

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