Organic Animal Breeding

Editors

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sonçağ akademi

TÜRKİYE ULUSAL AJANSI
TURKISH NATIONAL AGENCY

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PREFACE

IFOAM 2015 Organic Action Plan Report wants e-platforms to be created to increase national and international knowledge sharing in organic animal breeding in 2020 and beyond, the UK's organic knowledge to be shared internationally, and Spain to increase international cooperation.

IFOAM Organic 3.0 has determined the development and application of different-new ideas (innovation) as one of its strategic goals in order to adopt good practices and involve more farmers in organic production.

EU 7th Framework Program Final Report states that organic production is insufficient in the face of the increase in the number of organic markets, more producers should make organic production, technical personnel should be trained first and producers should be directed to organic production. It also emphasizes the importance of collecting and making usable the information obtained in organic livestock farming.

Turkey Organic Agriculture National Action Plan states that the target audience, which is one of the most important actors, should be trained for the development and dissemination of organic agriculture.

Due to these and similar calls, the national-international target audience of the e-lectures and e-book, which are the outputs of this project, will be Veterinarians, Agricultural Engineers and Agricultural Vocational High School Teachers working in the public sector (Ministry of Agriculture and Forestry and Agricultural Vocational High Schools in Turkey, and relevant ministries and high schools in other countries).

In this book, which was prepared within the scope of the project "e-Organic" (2020-1-TR01-KA202-093064) supported by the European Commision and Turkish National Agency, it was tried to provide information on 10 different topics on organic livestock to our valuable readers.

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Contents

UNIT 3:

ECOLOGY

UNIT 4:

ETHOLOGY

TÜRKİYE ULUSAL AJANSI
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UNIT 5

BREEDING

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UNIT 6

ANIMAL WELFARE and HEALTH

UNIT 7

REPRODUCTION

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UNIT 8

NUTRITION

UNIT 9:

FARM MANAGEMENT

UNIT 10:

FOOD SAFETY

UNIT 1:

HISTORY OF ORGANIC FARMING

INTRODUCTION

Since the first half of the 20th century, the negative effects of chemical agricultural inputs have been noticed by farmers, the general public and authorities, and more sustainable, environmentally friendly agricultural systems are being used. Within the scope of Albert Howard and Rudolf Steiner's studies, sensible producers and consumers came together in many European countries and started ecological agriculture practice. The practice gained an international attribute with the establishment of the International Federation of Organic Agriculture Movements (IFOAM) in 1972. Established by 5 founding organizations, IFOAM aims to gather the organic agriculture movements all over the world under one roof, to direct the development of the movement in a healthy way, to prepare the necessary standards and regulations (the first one was published in 1980), and to transfer all developments to its members and related sectors. The world trade in organic products developed in the 1980s, and in the late 1990s there was a significant increase in consumer demand for organic products, especially due to concerns and reactions to issues such as Bovine Spongiform Encephalopathy (BSE) and Genetically Modified Organisms (GMOs). The first regulation on organic agriculture in the world was published by the EU in 1991 and then many changes were made and the section on animal products was added in 1999. Food and Agriculture Organization of the United Nations (FAO), and World Health Organization (WHO) issued the Codex Alimentarius organic agriculture guideline in 1999, then the organic agriculture standards in the USA known as National Organic Standard (NOP) and JAS Organic in Japan, were added in 2000. All these codes and guidelines have affected market trends and product movements over the world. Nowadays, organic agriculture is carried out on approximately 72.3 million hectares of land in 187 countries. The countries with the largest amount of organic farmland globally are Australia (35.7 million hectares), Argentina (3.7 million hectares), and Spain (2.4 million hectares). The countries with the largest organic farmlands in Europe are Spain (14 percent of Europe's organic farmlands), France, Italy, and Germany.

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1. History

1.1. The Meaning and Emergence of Organic Farming

The term organic agriculture refers to a process that uses environmentally friendly methods from the production stage to the processing stage. Organic production is focused on a product and the entire system in which the product is produced and delivered to the ultimate consumer. There are two primary sources globally for general principles and requirements in organic farming. First is the Codex Alimentarius guidelines for producing, processing, labeling, and marketing organically grown foods. According to this guideline, organic farming is a holistic production management system supporting and improving ecosystem health including biological cycles and soil microbiome. It is based on minimizing the usage of external inputs, synthetic fertilizers and pesticides. Its practices cannot guarantee that products are entirely residue-free because of environmental pollution. However, some methods are used to minimize air, soil, and water pollution. Organic food processors and retailers adhere to standards to protect the integrity of organic products. The fundamental purpose of organic agriculture is optimizing the health and productivity of interconnected communities such as soil microorganisms, plants, animals and people. The second guideline is the International Federation of Organic Agriculture Movements (IFOAM), an international organization with approximately 800 organizations from over 100 countries. IFOAM defines and constantly reviews the standards that shape the term organic by using the knowledge of its members. As defined by IFOAM 2002 core standards, organic agriculture is a holistic system based on a set of processes resulting in a sustainable ecosystem, secure food and nutrition, animal welfare, and social justice. Therefore, organic production is more than a system that only includes or excludes specific inputs. The last and current organic agriculture definition was adopted by IFOAM members general assembly of June 2008 in Vignola (Modena, Italy) it recites: Organic agriculture, a production system, sustains the health of soils, ecosystems, and people. In Organic Farming, inputs with negative effects are not used, organic farming is more based on ecological processes, biodiversity and cycles adapted to local conditions. Organic Farming combines many elements to benefit the shared environment, It also combines tradition, innovation and science to promote fair relations and good quality of life for all concerned.

Unlike "environmentally friendly", "green" or "free-roaming" food labels, "organic label" refers to the compliance with specific production and processing methods. All current organic farming standards prohibit the use of most synthetic pesticides, fertilizers and preservatives, any genetically modified organisms, sewage sludge, and irradiation. Adherence to organic agriculture standards, including consumer protection against fraud practices, is achieved through auditing and certification. Most of the industrialized countries have regulations governing the foods labeled as organic. Biological or ecological are used as terms referring to organic depending on the language.

Organic livestock production within the organic farming system focuses predominantly on animal production from a pasture based feed system, preserves animal health through improved welfare which results in a lower usage of conventional veterinary treatments. Reproduction and feeding are essential factors for the health and well-being of livestock in organic systems.

Organic livestock production standards emphasize:

- ✓ Care of closed herds and flocks; breeding on the farm replacements to develop herds/flocks that adapt to specific farm conditions and minimize the risk of bringing disease from other holdings.
- ✓ Use of organically produced animal feed, where pasture is insufficient.
- ✓ Avoid unnecessary use of veterinary drugs and pesticides to reduce possible adverse health effects.
- ✓ Providing animals the living conditions and opportunities compatible with their physiological needs, natural behavior, and general well-being.
- ✓ Use of traditional and native breeds/species which are adapted to local conditions.
- ✓ Conservation/cultivation of genetic diversity.

The following four principles should be adopted in order to realize organic agriculture according to the IFOAM (International Federation of Organic Agriculture Movements):

- ✓ **Principle of Health:** The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to maintain and improve the health of ecosystems and organisms, from small microorganisms living in the soil through to humans. Organic farming aims to produce high-quality, nutritious food that contributes positively to human health preventing illness and increasing longevity. In order for organic farming to meet the principle of health, fertilizers, pesticides, animal medicines, and food additives, which may have adverse effects on health, should be avoided.
- ✓ **Principle of Ecology:** This principle states that production must be based on ecological processes and recycling. Nutrition and welfare are provided through the ecology of the particular production environment. For instance, when it comes to crops, this production environment is soil; for animals, it is the farm ecosystem; for fish and marine organisms, it is an aquatic environment. Organic farming must achieve ecological balance through the design of farming systems, the creation of habitats, and by maintaining genetic and agricultural diversity. Those who produce, process, trade, or consume organic products must protect and benefit from the everyday environment, including landscapes, climate, habitats, biodiversity, air, and water.
- ✓ **Principle of Justice:** This principle emphasizes that those engaged in organic agriculture must conduct human relations in a manner that ensures justice at all levels and to all parties-farmers, workers, processors, distributors, traders, and consumers. Organic farming should provide a good quality of life for all involved

and contribute to food sovereignty and aid in reducing poverty. It aims to produce sufficient quantities of quality food and other products. This principle insists that animals should be provided with living conditions and opportunities suitable for their physiology, natural behavior, and welfare. Biological and environmental resources, used for production and consumption, should be fairly managed both socially and ecologically so that they can be entrusted to future generations. Fairness requires straightforward, and egalitarian systems of production, distribution, and trade that take actual environmental and social costs into account.

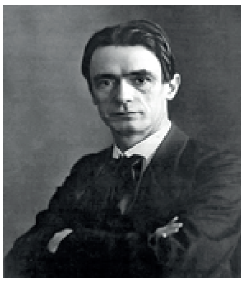
- ✓ **Principle of Care:** This principle states that the most critical points in organic agriculture (in terms of management, development, and technology) are precaution and responsibility. Science is necessary to ensure that organic farming is healthy, safe, and ecologically sound, but scientific knowledge on its own is not enough. Practical experience, accumulated wisdom, traditional practices and domestic knowledge provide reasonable solutions that are time-tested. Organic farming should avoid significant risks via adopting appropriate technologies and also rejecting unpredictable ones such as genetic engineering. Decisions should be transparent and reflect the values and needs of all who may be affected through participatory processes.

Organic livestock systems are also guided by IFOAM's health, ecology, justice, and care principles.

- ✓ The Principle of Health emphasizes the interdependence of different parts of the system, and promotes high animal health through management and husbandry practices focused on preventing disease.
- ✓ The Principle of Ecology implies integrating livestock farming with products for nutrition and nutrient recycling on the farm or in the region.
- ✓ The Principle of Justice refers to respect for animal rights.
- ✓ The Principle of Care places the responsibility of treating animals humanely to the people who work with these animals.

1.2. Historical Development of Organic Farming

1.2.1. Early Attempts, Pioneers, and Legal Regulations



The principles of organic agriculture are compatible with the principles of biodynamic agriculture and permaculture. Biodynamic agriculture, initiated by **Rudolf Steiner**[1] in 1924, adopts the holistic and spiritual understanding of the farm, in which nature and the farm are a self-sufficient evolving organism that keeps external inputs to a minimum. It also utilizes biodynamic preparations, and unlike conventional farming promotes economic relations between producers,

1 **Rudolf Stainer's photo was taken https://tr.wikipedia.org/wiki/Rudolf_Steiner.**

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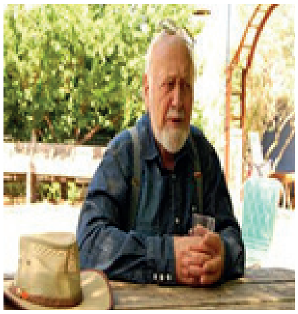
processors, traders, consumers. It also promotes fair trade, being compatible with the natural cycles of cultivation. The certification requirements of biodynamic agriculture (labeled under the Demeter international network in Australia, America, Africa and Europe)



which includes many organic standards recognized under the Unified Organic Food Standards Registry and government-owned organic aid programs. In the late 1970s, ecologist **Bill Mollison**[2] developed the concept of permaculture as interdisciplinary geoscience. Permaculture is a landscaping and social design system that works to conserve energy in the field (e.g., crop, firewood, food calories) or produce more energy than it consumes. The care of natural communities (including wildlife), rehabilitation of degraded land, and local self-sufficiency are central to permaculture. Permaculture does not have a specific certificate, but this management approach has been adopted by organic agriculture.

In 1840, the German chemist **Justus von Liebig**[3] developed a theory on mineral plant nutrition. He believed that the only nutrient that plants needed was mineral salts so that they could replace the need for fertilizers. Liebig is known as the father of the fertilizer industry because he discovered nitrogen, which is an essential plant nutrient. In 1910, chemists Fritz Haber and Carl Bosch developed ammonia synthesis by using nitrogen from the atmosphere. This form of ammonia has already been used to produce explosives and has been made available for fertilizer in agriculture. With these two breakthroughs, the use of chemicals in agriculture was born. Within 20 years of using chemicals in agriculture, the negative effects were seen by farmers, environmentalists and the authorities worldwide. Consumers became more interested in where their food comes from and how it is produced, focusing agriculture towards a more eco-friendly farming system, which can be classed as organic farming.

Erosion, reduced crop diversity, low quality food and animal feed, and rural poverty were drivers for the pioneers of the early organic movement. People wanted to reverse these negative effects. A holistic idea of the nation's health based on agriculture depends on the long-term viability of its land. It was believed that the health and vitality of the soil are embodied in its biology and in the organic soil fraction known as humus.

The agricultural culture of the Far East influenced people's experiences in the early stages of organic agriculture. Agricultural scientists and researchers in Germany and the U.K.

2 **Bill Mollison's photo was taken https://tr.wikipedia.org/wiki/Bill_Mollison.**
3 **Justus von Liebig's photo was taken https://tr.wikipedia.org/wiki/Justus_von_Liebig.**

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have shown early interest in the science behind agricultural methods, which are today considered the precursor of organic food production. Many publications based on travel to other parts of the world have been influenced by the emergence of organic methods. Organic farming movements began at about the same time in Central Europe and some parts of India. Sir **Albert Howard**[4] is perhaps the most prominent name among the pioneers of agriculture, going as far to name him the father of organic agriculture. Howard developed and promoted a vision of agricultural production and land management based on returning composted organic waste to farm fields. Howard emphasized the role of organic agriculture in improving individual and social health and maintaining soil fertility for future generations. As a British botanist, Howard, recognized and documented traditional Indian agricultural practices as superior to conventional agriculture while working as a farming consultant in Benegal between 1905-1924. He discovered connections among the health of soil, animals and plants grown in that soil. He compiled these experiences in his book, The Waste Product of Agriculture. In healthy soil, healthy animals and plants grow, then the final product will be healthy people. This result depends on returning waste products to the soil and the resumption of life in humus form. In 1943, Howard published a new book called An Agricultural Testament, which advocated farming without fertilizers and pesticides. Later, in 1947, he published a book called A Study of Organic Agriculture. The Medical Testament, published on March 22, 1939, by 31 doctors of the Cheshire Panel Committee in England, is based on Howard's work on crop breeding and Sir Robert McCarrison's nutrition.

In 1909, American agronomist **Franklin Hiram King**[5] traveled through China, Korea, and Japan to study traditional fertilization, tillage, and conventional agriculture practices. He returned with organic culture ideas and published his his findings in his book Permanent Agriculture: Farmers of Forty Centuries. King described a permanent agriculture system based on crop rotation, green fertilization, alternation, and recycling of organic substances. He was recognized as the father of soil physics in the United States. Both Howard and King have made significant contributions on understanding the methods used for centuries in areas where population density and pressure on natural resources are high.

4 Albert Howard's photo was taken https://en.wikipedia.org/wiki/Albert_Howard.

5 Franklin Hiram King's photo was taken https://en.wikipedia.org/wiki/Franklin_Hiram_King.

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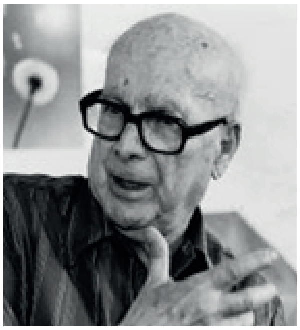
Rudolf Steiner is the founder of the philosophy of Anthroposophy. Founded by Rudolf Steiner, Anthroposophy is a type of rationalized mysticism, an esoteric current of thought that seeks to explore and describe metaphysical phenomena with the precision and clarity with which the natural sciences explore and describe the physical world. The Anthroposophical Society, which is founded by Rudolf Steiner in Austria in 1912, currently operates through Demeter's International Foundation. Biodynamic agriculture was developed in Germany, Switzerland, England, Denmark, and the Netherlands in the late 1920s. As a result of this movement, the first organic labeling system Demeter was created in 1924 based on Steiner's ideas. In 1924 he lectured on the social scientific basis of agricultural development. The main idea of his lessons was that man must live in harmony with the environment as the main part of cosmic balance.

In 1913, Rudolf Steiner published Spiritual Foundations for the Renewal of Farming, which could be the first comprehensive publication in Germany that led to the development of the organic farming system and biodynamic farming. Steiner emphasized the role of farmers in guiding and balancing the interaction of animals, plants, and soil. According to Steiner, healthy animals depend on healthy plants for their food. Healthy plants depend on healthy soil, and healthy soils depend on healthy animals for fertilizer. As a result, a biological cycle exists. Rudolf Steiner believed that farmers should feed the soil, not the plants. He, therefore, regarded the soil as an agricultural organ, which is a digestive organ of the plant. With this viewpoint, Steiner had created a thesis against industrial nitrogen fertilization methods in those days. It was soon discovered that these nitrogen salts reduced the quality while promoting plant growth. According to Steiner's understanding, when a farm is only considered a self-sufficient, independent entity and a unique business, it has entirely found its identity. Steiner's ideas today have a practical impact not only in agriculture but also in education, medicine, and the arts.

Hans Müller[6] and his wife Maria Müller became pioneers of organic agriculture in Switzerland, and the countries speaking German collaborated with Hans Peter Rusch. Hans Müller, one of the politicians, accelerated organic-biological agriculture in Switzerland in the 1930s and 1940s. He planned a rather direct and simplified relationship between producers and consumers. Maria Müller, his wife, who grew up on the farm like him, applied these production theories to fruit gardens.



6 **Hans Muller's photo was taken http://organic.com.au/people/hans-muller/.**

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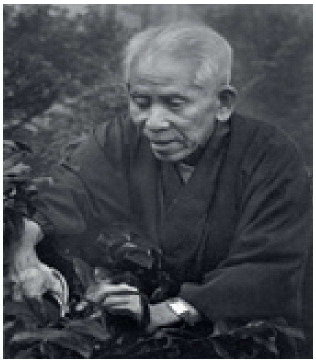


Mokichi Okada[7] started practicing eco-agriculture in 1936. There were some similarities between the works of Mokichi Okada and the ideas of Rudolf Steiner. According to Mokichi Okada, harmony and welfare among living beings result from the preservation of a natural environment. Thanks to the principle of recycling natural resources found on a farm, the soil becomes more productive. This principle makes nutrients free in the soil for plants because of decomposition of organic matter by beneficial microorganisms like bacteria and fungi.

Rudolf Steiner's student **Ehrenfried Pfeiffer**[8], a German soil scientist, is one of the leaders of biodynamic agriculture. Ehrenfried Pfeiffer moved to the United States, consulted with those interested in biodynamic agriculture, and helped the founding of the Biodynamic agriculture and Horticultural Society in 1940. He worked closely with his mentor Rudolf Steiner to test and document the effects of biodynamic practices. He served as a bridge to transfer biodynamic concepts to the English-speaking world. In 1938, Pfeiffer published his book Bio-Dynamic Farming and Gardening Soil Fertility Renewal and Preservation, the first popular book about biodynamic agriculture. After that, Pfeiffer became the Bio-Chemical Research Laboratory director at Goetheanum, the center of the anthroposophy movement in Dornach, Switzerland. Pfeiffer played an essential role in testing Rudolf Steiner's ideas and converting them into biodynamic agriculture.

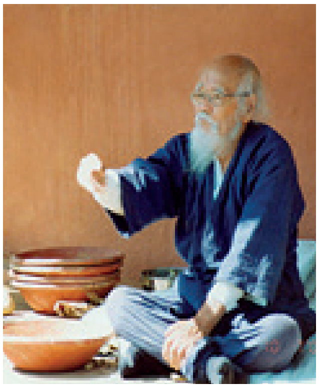
Organic farming term was first used by Lord Northbourne. With interest in biodynamics, Northbourne visited Pfeiffer in Switzerland in January 1939 to organize the first biodynamic conference in the U.K. The following year, Northbourne's book Look to the Land was published. Northbourne's book describes the philosophy, logic, and necessity of organic agriculture rather than the mechanics or practices of organic agriculture. Northbourne wrote in his book:

- ✓ The farm itself must have biological integrity.
- ✓ It must be a living being.
- ✓ It must be a unit with a balanced organic life within itself.
- ✓ A fertilizer-based farm can neither be self-sufficient nor an organic whole.
- ✓ Soil and microorganisms should form an organic whole together with the plants growing on it.

7 Mokichi Okada's photo was taken https://en.wikipedia.org/wiki/Mokichi_Okada.

8 Ehrenfried Pfeiffer's photo was taken https://anthrowiki.at/Ehrenfried_Pfeiffer.

In his book, he described a holistic, ecologically balanced approach to farming and wrote the article Organic Versus Chemical Farming. Rudolf Steiner also influenced **Lord Northbourne**[9]. Northbourne used the term organic farming to describe agricultural systems that focus on agriculture as a dynamic, living, balanced, organic whole or an organism. According to some opinions, he adopted the Northbourne Terminology in Sir Albert Howard's book A Study of Organic Agriculture, published in 1947.



In Japan, **Masanobu Fukuoka**[10], a microbiologist who worked in soil science and plant pathology, began to doubt the modern agricultural movement. He quit his job as a research scientist in the early 1940s, returned to his family's farm, and devoted the next 30 years to developing a revolutionary organic method for producing grain, now known as Fukuoka Agriculture. Fukuoka was a farmer and philosopher who led a farming school called a natural farming or do-nothing farm. Fukuoka's methodology required minimal human intervention in the agricultural process; instead of human interference, it created conditions in which biological processes maximized crop yields at their will. From 1938, Fukuoka experienced new techniques while growing organic mandarin. His observations helped him discover the concept of natural agriculture. In 1939 his role as the Chief of Plant Diseases and Insect Control Research in Kochi Province allowed him to work on this theory, however his work was interrupted due to the outbreak of World War II. After World War II., as a result of the redistribution of territory entailed by the American occupying forces, Fukuoka's father has lost most of his land. What remained was less than half an acre of rice field and a fruit garden he handed over to his son before the war. Despite all these misfortune, Fukuoka successfully returned to natural agriculture by growing barley and rice without plowing the soil in 1947. In 1964, he wrote his first book, Mu 1: The God Revolution, and began working to spread the benefits of his methods and philosophy at the same year. The One-Straw Revolution, his next book, was published in 1975 and it was translated into English in 1978. According to Fukuoka, the five known principles of natural agriculture are:

9 **Lord Northbourne's photo was taken http://www.worldwisdom.com/public/authors/Lord-Northbourne.aspx.**

10 **Masanobu Fukuoka's photo was taken https://tr.wikipedia.org/wiki/Masanobu_Fukuoka.**

- ✓ Plowing and processing of the land by people is as unnecessary as the use of machinery.
- ✓ It is unnecessary to use chemical fertilizers and prepare compost.
- ✓ Weeding is unnecessary, and weeds can be kept at a certain level with minimal intervention.
- ✓ The use of pesticides and herbicides is unnecessary.
- ✓ Pruning fruit trees is unnecessary.

Jerome Irving Rodale[11] was an entrepreneur with a great interest in organic agriculture. His interest in organic farming was sparked by Howard mentioned above. Inspired by him, he wrote, "I decided that we should own a farm and grow most of our family's food as organically as possible." In 1940, Rodale and his wife Anna bought a 63-acre farm in Pennsylvania, and embarked on transforming the property into a model for organic methods. Rodale conducted numerous growing experiments and noticed that his health and the soil had improved. He felt compelled to share his findings and published the first issue of Organic Farming and Gardening in 1942. Developing and demonstrating practical, natural methods for improving soil fertility became Rodale's primary purpose. When the sudden nitrogen fertilizer shortage during the World War II occured, it revealed the country's soil's were poor in nutrient and overall health. In 1947, Rodale founded the Soil and Health Foundation, which later became the Rodale Institute. As Rodale conveyed his idea of creating nutrient-rich and pollutant-free soil, people began to listen and accept his proposals. With the publication in 1948 of Pay Dirt, a book about the links between chemical agriculture and increasingly deteriorating public health, Rodale found himself at the head of a movement with the Rodale Institute being one of the founding members of IFOAM in 1972.

Lady Eve Balfour[12] is best known as the founder of the Soil Association, the U.K.'s leading organic food and agriculture organization. The Soil Association was founded in 1946 after Balfour's book on organic farming, The Living Soil was published. She received her agricultural education at Reading University College during the World War I. After managing a farm in Wales for a short time, she and her sister Mary bought a farm in Suffolk. In 1938, Lady Eve Balfour's conversion to compost-based humus farming and her rejecting inorganic fertilizers opinion led her to

11 Jerome Irving Rodale's photo was taken https://en.wikipedia.org/wiki/J._I._Rodale.

12 Lady Eve Balfour's photo was taken https://en.wikipedia.org/wiki/Lady_Eve_Balfour.

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decide turning her farms into a research project to demonstrate the superiority of organic farming methods. Balfour conducted the Haughly experiment, which compared the microbial benefits of organic agriculture to conventional agriculture, from 1939 to 1972. With this study, Balfour demonstrated that microbial activity of soil increased in organically managed plots contrary to traditionally managed plots, while harmful pest infestations were less prominent in organic areas. These results demonstrated that organic farming benefits both the environment and the individual. Balfour has created an awareness of the inseparable link between human health and food production. Following the publication of The Living Soil and the establishment of the Soil Association, Balfour became one of the most important representatives of organic agriculture. In the 1950s, she traveled to North America, Australia, New Zealand, and many European countries sharing the organic farming view and creating networks with supporters. Balfour also took part in creating the IFOAM.

Although Balfour's work had a relatively significant impact, the view that chemical-intensive agriculture is good wasn't deeply challenged until 1962. This outcome came with the release of Rachel Carson's Silent Spring, which points to the immediate threats of applying synthetic agrochemicals to human health. The National Audubon Society hired **Rachel Carson**[13] in 1957 to investigate the dangers of the use of DDT and other pesticides. In addition to reading scientific literature and participating in Food and Drug Administration sessions on the use of chemical pesticides in food crops, Carson held extensive interviews with scientists and doctors to learn about the effects of pesticides. Silent Spring was first published as a series in The New Yorker and then as a book by Houghton Mifflin. Carson has documented the enormous harmful effects of pesticides on the environment. And he argued that because of the effects of pesticides on organisms other than the target pests, they should be appropriately called biocides. Carson changed the public's view of synthetic pesticides by combining research that revealed specific consequences of exposure to pesticides, from cancer to infertility. Carson talked about neighborhoods where bird song had disappeared due to pesticide exposure killing all the birds. She spoke about lakes and rivers being polluted and turning fish toxic for human consumption. Finally her statements on babies in the womb developing cancer, or cancer post birth due to maternal exposure to carcinogenic chemicals during pregnancy made a real statement to the public. In contrast, her research focused on acute symptoms of chemical exposure such as cancer and congenital disabilities. She referred to a topic known as endocrine disruption that was later more deeply investigated by Theo Colborn and her colleagues. Balfour and then Carson planted the seeds of an international political

13 Rachel Carson's photo was taken https://en.wikipedia.org/wiki/Rachel_Carson.

and environmental movement by raising public awareness of the links between agricultural practices and the health of lands and people.

1.2.2. Organic Farming and Environmental Movement after Industrialization and Commercialization

The idea of organic farming developed in the early twentieth century with urbanization and the rise of agrochemical inputs usage in agriculture. The organic movement started in German and English-speaking countries and has been influenced by rural traditions and different groups supporting biological inputs and reducing external influences. The organic movement has remained under-appreciated for several decades but has gained popularity since the 1970s with growing public concerns about industrialized farming's health and environmental impacts. Some of the efforts that contributed to the organic movement in this period were the studies in the political and economic field. For example, The Limits to Growth by Meadows, et al., (1972) focused mainly on the consequences of the rapidly growing world population and limited resources. During this period, **Ernst Friedrich Schumacher**[14], president of The Soil Association, discussed the need for a new lifestyle and economic structure based on ecological and spiritual values published in 1973, Small is Beautiful. Since the mid-1980s, organic agriculture has become an essential focus of policymakers, consumers, environmentalists, and farmers in Europe. This milestone coincided with growing concerns about the negative environmental and some other impacts of post-war agricultural development and also the introduction of policies to support agri-environmental initiatives, including organic farming. In addition, state support for organic agriculture began in the late 1980s with national initiatives in countries such as Denmark, Austria, Switzerland and programs in several E.U. member states under the E.U. Extensification Program (Commission Regulation (EEC) No. 4115/88).

A meeting held in Versailles, France, on November 5, 1972, marked a significant milestone for the establishment of the organic agriculture movement and the Federation of Organic Agriculture Movements. The organizer of this meeting was Roland Chevriot, an engineer and chairman of the French national farmers' organization Nature et Progrès. Nature et Progrès was founded in 1964 by agronomists, doctors, farmers, and consumers. It was created to improve organic production, promote the benefits of organic food, and pay attention to the possible detrimental effects of modern agriculture and pesticides. Five founding members representing different organizations attended this meeting. They were Balfour representing the Soil Association (UK), Kjell Arman who represents the Biodynamic Association (Sweden),

14 Ernst Friedrich Schumacher's was taken photo https://en.wikipedia.org/wiki/E._F._Schumacher.

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Pauline Raphaely who represents the Soil Association (South Africa), Jerome Goldstein who represents the Rodale Press (US), and Roland Chevriot who represents Nature et Progrès. The founders believed that the federation could respond to the need for a unified, organized voice for organic food and the dissemination and exchange of information across national and linguistic boundaries about the principles and practices of organic agriculture. By 1975, IFOAM had grown to 50 members in 17 countries. The first IFOAM conference focus was the Towards: A Sustainable Agriculture, held in Switzerland, in 1977. One hundred seventy-nine participants from 13 countries participated. By 1984, IFOAM had reached 100 members from 50 countries, 500 members in 75 countries in the following five years. At present, IFOAM has over 800 members from over 100 different countries.

IFOAM published the basic standard for organic production and processing first in 1980 as a guiding tool for all members. In the same decade, legislators in several countries and regions began to issue certain standards relating to organic agriculture (California, France, Austria, some Italian regions). After that, the organic movement became more organized and strengthened via a close relationship between consumers and the environmental movement. In 1990, a federal norm for organic farming began to develop in the United States and later became the United States Department of Agriculture's National Organic Program. In 1991, the European Commission, started to work on the organic farming directive, which became a Council Regulation (EC Reg. 2092/91), which came into force on January 1, 1993. In July 1992, the Codex Alimentarius Commission decided that the Codex Food Labeling Committee could discuss and develop the guidelines on the production, processing, marketing, and labeling of organically produced foods. At its 23rd session in 1999, the Codex Alimentarius Commission embraced the guidelines on producing, processing, labeling, and marketing of organically grown foods, excluding provisions on livestock and livestock products. In 1999, a specific norm, the Japanese Agricultural Standard (JAS) for organic agricultural products, was established in Japan. In its 24th session in 2001, the Codex Alimentarius Commission adopted the chapters on livestock and livestock products, as well as beekeeping and bee products for inclusion in the guidelines. For the first time in Turkey, the Regulation on the Production of Herbal and Animal Products by Ecological Methods was published in 1994. Finally, the Organic Agriculture Law was passed in 2004 and then in 2005 the Regulation on the Principles and Application of Organic Agriculture, which was regulated in 2018 guided by the latest organic agriculture law of the E.U.

In October 2011, the General Assembly of IFOAM-Organics International recommended that IFOAM should give livestock more priority. A group of relevant people supported by the IFOAM world Board contributed to establishing the IFOAM livestock Alliance (IAHA) in November 2012 with the approval of the world Board. IAHA is a global platform that addresses animal health and welfare, breeding techniques, feeding, and related issues.

Located in Frick (canton of Aargau) since 1997, the Organic Agriculture Research Institute (FiBL) was established in 1973. This institution is one of the world's leading research and knowledge centers for organic farming. The Organic Agriculture Research Institute (FiBL) employs 200 experts in Switzerland. FiBL Germany was founded in 2001, FiBL Austria in 2004, and FiBL France in 2017. In addition, FiBL Europe, headquartered in Brussels, was established in 2017 to represent four national FiBL research institutes; FiBL Switzerland, FiBL Germany, FiBL Australia, FiBL France, and the Hungarian Organic Agriculture Research Institute, OMKI at the European level.

1.3. Organic Farming Statistics in Turkey and Europe

Organic farmland is growing, according to the latest FiBL research on organic farming worldwide. In addition, organic retail sales continued to grow. As a result, it reached the highest rate of all time according to the data of 187 countries. 72.3 million hectares of organic farmland were recorded in 2019, including transitional. This area had increased by 1.1 million hectares, which was a 1.6% increase compared to 2018. Two-thirds of organic farmland was grassland/ grazing areas (about 49 million hectares) that also increased by 1.2% in 2019 **(Figure 1)**.

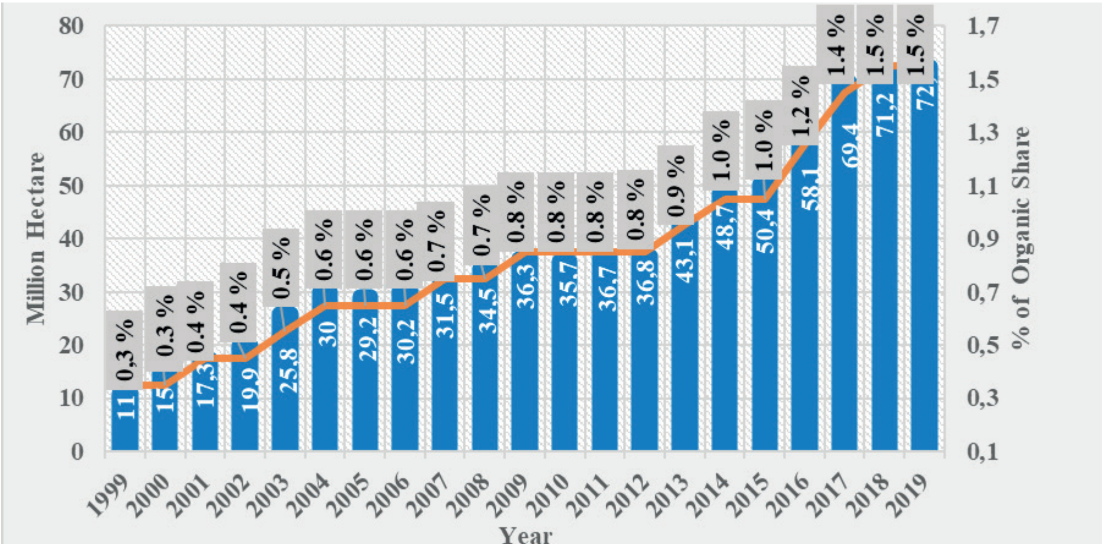

Figure 1. Growth of the world's organic farmland and organic share

The regions with the largest organic farmland areas were Oceania (35.9 million hectares, half of the world's organic farmland) and Europe (16.5 million hectares, 23 percent of the world's organic farmland). Latin America, which had 8.3 million hectares (11% of the world's organic farmland) of organic farmland, was followed by Asia (5.9 million hectares, 8% of the world's organic farmland), North America (3.6 million hectares, 5% of the world's organic farmland), and Africa (2 million hectares, 3% of the world's organic farmland). Globally, the countries with the most organic farmland were Australia (35.7 million hectares), Argentina (3.7 million hectares), and Spain (2.4 million hectares). In Europe, the countries with the largest organic land areas were Spain (14 percent of Europe's organic farming areas), France, Italy, and Germany in 2019 **(Figure 2)**.

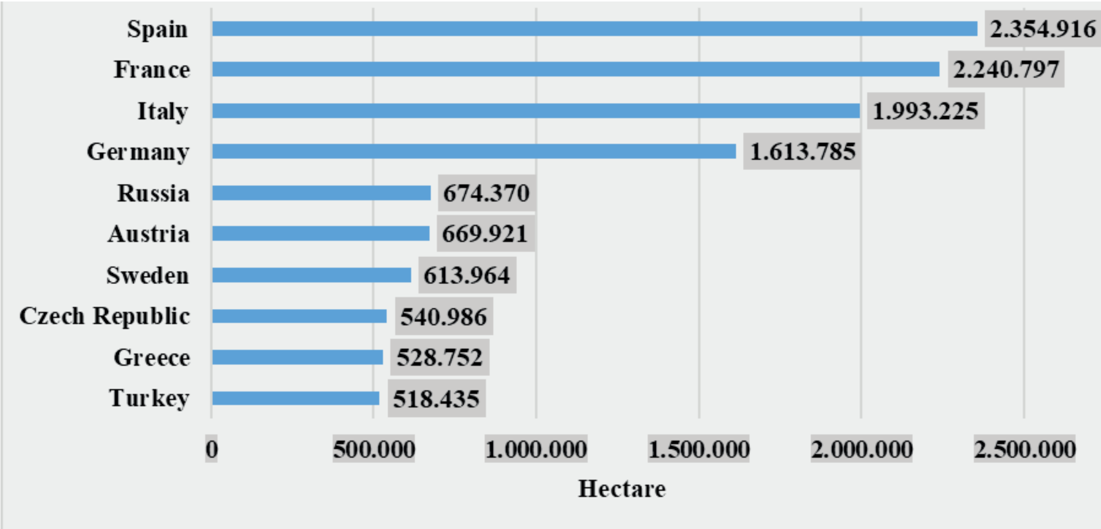

Figure 2. Europe: Presence of organic farmland by country in 2019

According to FiBL, organic food and beverage sales reached more than 106 billion Euros in 2019. United States (44.7 billion Euros), Germany (12.0 billion Euros), and France (11.3 billion Euros) were the countries with the largest organic markets in 2019. USA was the largest single market (42% of the global market), followed by the European Union (41.4 billion euros, 39%) and China (8.5 billion euros, 8%). In 2019, the highest consumption per capita was in Denmark with 344 euros. The highest organic market shares were achieved in Denmark (12.1%), Switzerland (10.4%), and Austria (9.3%).

There are more than 3.1 million organic producers around the world. According to the data obtained, more than 9% of the producers are in Asia, Africa, and Europe. The country with the most organic producers is India, which is followed by Uganda and Ethiopia **(Figure 3)**.

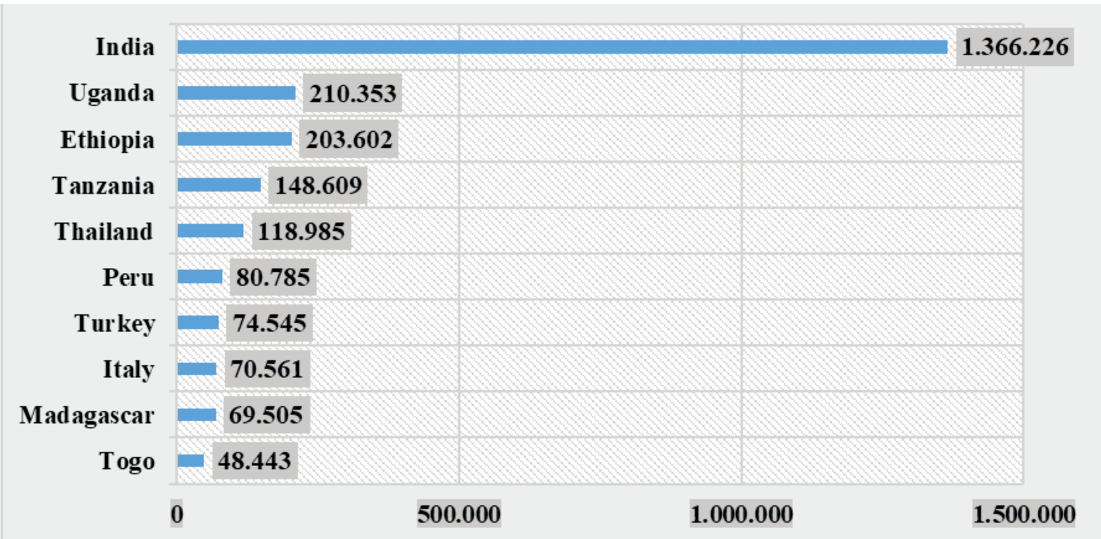

Figure 3. World: The ten countries with the most organic producers in 2019

In 2019, there were more than 430.000 organic producers in Europe. Countries with the most organic producers in Europe are Turkey, Italy, and France, respectively **(Figure 4).**

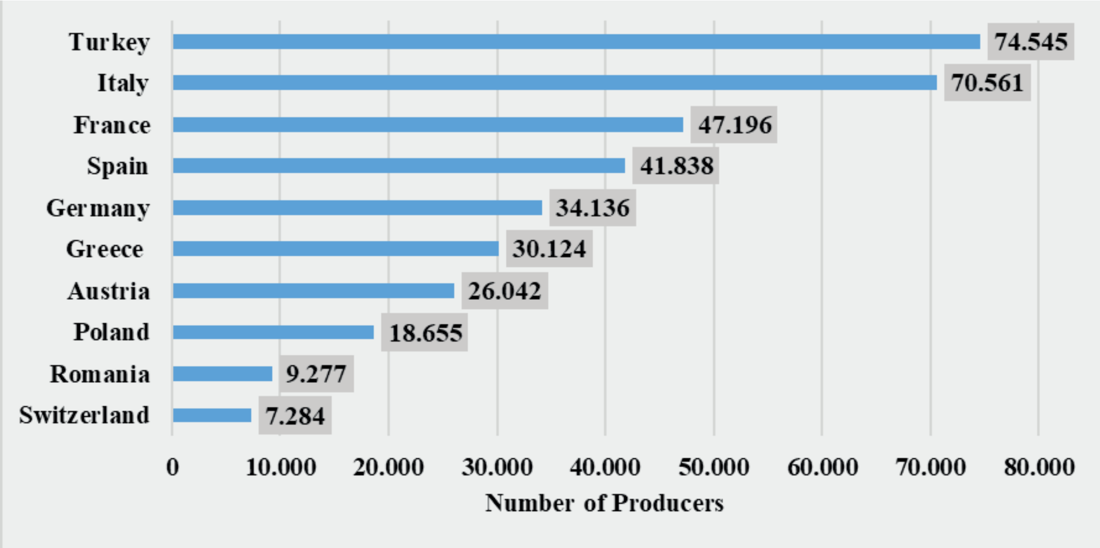

Figure 4. Europe: Ten countries with the most organic producers in 2019

When the use of organic farming lands in the world was examined, grains ranked first with a planted area of 5.073.137 hectares. Oilseeds followed this with 1.676.502 hectares and olive fields with 881.543 hectares **(Figure 5)**.

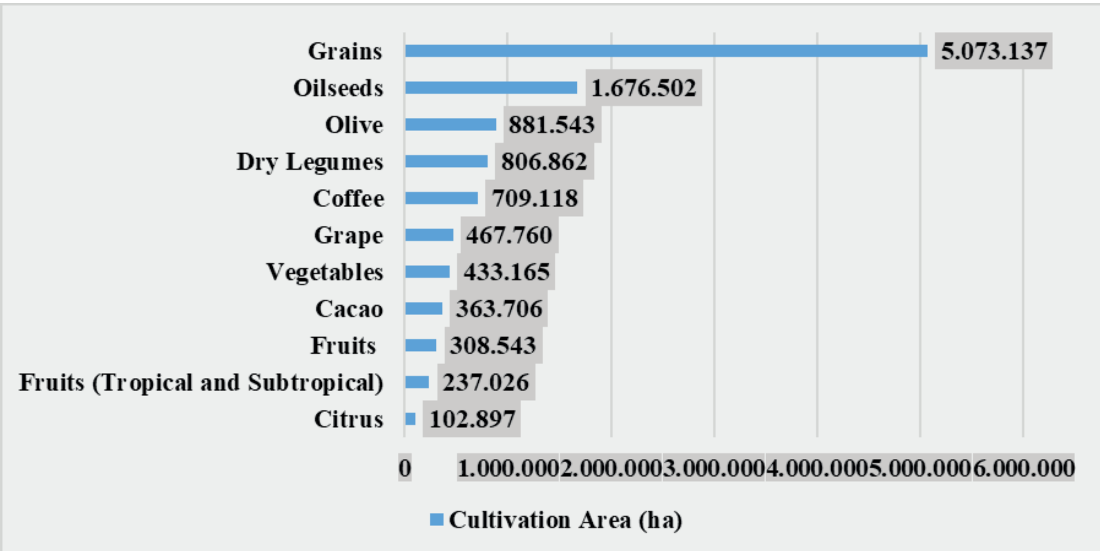

Figure 5. Organic farming areas by selected main product groups in 2019

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Around 5.1 million hectares, 0.7% of the global grain area, were under organic management according to the statistics in 2019 **(Figure 6)**.

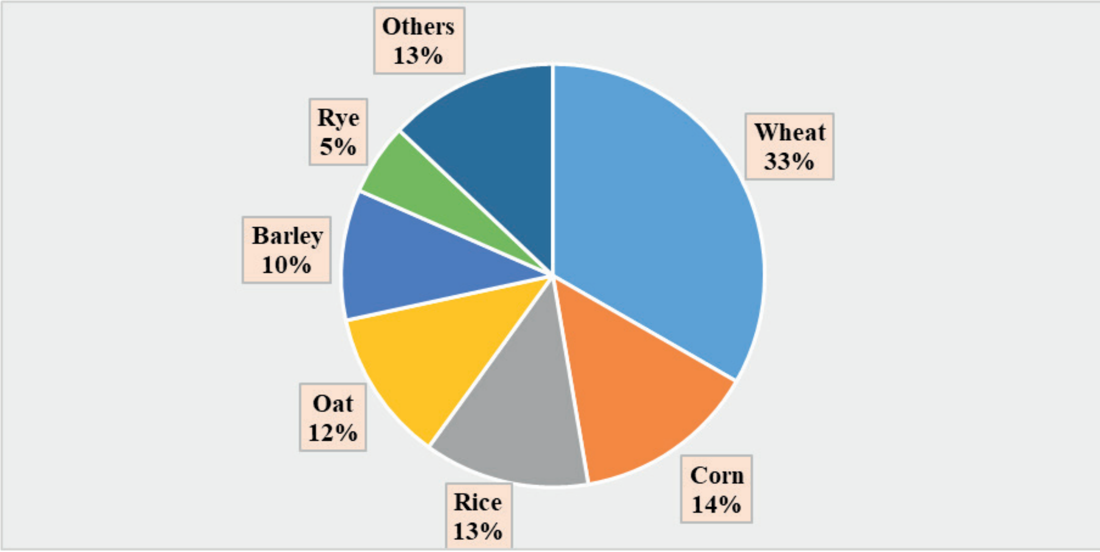

Figure 6. Distribution of global organic grain fields by grain type in 2019

More than 1.676.000 hectares, 0.7% of the global oilseed area, were under organic management in 2019 **(Figure 7)**.

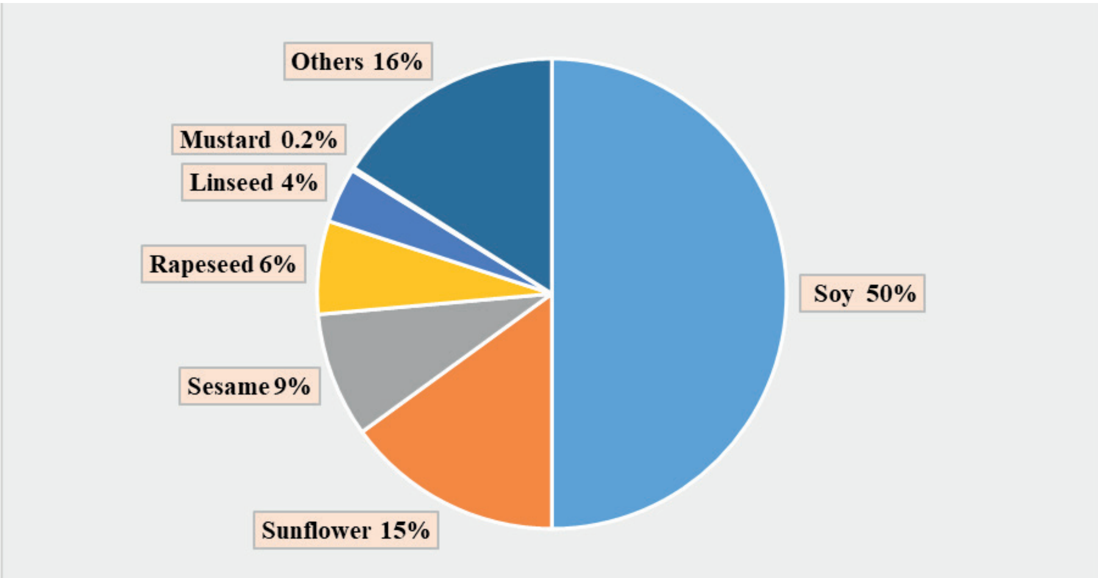

Figure 7. Distribution of global oilseed areas by crop type in 2019

In 2019, the E.U. imported 3.24 million tons of organic agri-food products. Almost a third of organic imports into the E.U. is imported by the Netherlands (32%). The other E.U. members import a significant portion of organic products including Germany (13%), the United Kingdom (12%), and Belgium (11%). Most of the E.U.'s imports from China include organic oily cakes. In contrast, E.U. imports organic tropical fruits from Ecuador, the Dominican Republic, and Peru; nuts and spices, organic grains from Ukraine, Turkey, and Kazakhstan; and organic sugar from Brazil and Colombia.

The top ten most imported product categories represented 82% of total organic import volumes in 2019. Tropical fruits, nuts, and spices come in first place with 27% (0.9 million M.T.), followed by 12% (0.4 million M.T.) in oily cakes, grains other than wheat and rice, and beet and cane sugar (both 7%). 0.2 million M.T.). Oily cakes are a vital feed component for E.U. livestock production, especially for organic pork and poultry.

Honey is the main imported organic animal product. In 2019, organic honey imports were around 18 billion tons. China, Mexico, and Brazil are the leading countries that export egg and honey to the E.U. Beef and non-edible animal products are mostly imported from Uruguay. Organic sheep and goat meat are of New Zealand origin.

The organic livestock sector is rapidly developing in European countries. In 2019, 5.1 million cattle, more than 5.4 million sheep, nearly 1.6 million pigs, and more than 62.3 million poultry were grown organically in Europe. Between 2010 and 2019, the most considerable increase was in poultry (110%) due to the high demand for organic eggs. In addition to this, during the same period, the increase in cattle was approximately 80.9%, 55.33% in sheep, and 109.6% in pigs. For cattle, the countries with the highest numbers are Germany, France, and Austria. In contrast, for sheep, the highest numbers are Greece, the United Kingdom, and France, for pigs; according to the available data, the countries with the highest numbers are Germany, Denmark, France, and the Netherlands.

Organic cow milk has nearly doubled since 2007 to meet the growing demand for milk and dairy products. The production stands at 6.35 million tons, and 3.4 percent of the European Union's organic milk production from dairy cows in 2019.

In the early 1990s, organic foods were first introduced on a large scale. It was more than 15 years for global organic product sales reaching USD 50 billion in 2008. After ten years (2018), the USD 100 billion limits have been exceeded because with COVID-19 pandemic, humans changed the way they shop and eat. The next jump to USD 150 billion could probably be in the next few years. There has been an increase in organic food sales during the coronavirus outbreak. Retailers around the world have reported that significant sales occurred during the virus outbreak in March 2020. It is believed that As consumers are interested in personal health, wellness, and nutrition, all n, the trends of organic food, hence consumption has increased. International organic food and beverage sales reached USD 112 billion in 2019. The market expanded by 55% since 2013.

While the products obtained from organic agriculture are certified according to the organic agriculture regulations of the countries, the products obtained from biodynamic agriculture also are certified according to the International Demeter Biodynamic Agriculture Standard. Demeter is the only ecological association to establish a worldwide network of individual certification bodies. There are currently 6400 Demeter farmers in 62 countries with an area of more than 220.000 hectares. Biodynamic viticulture is also becoming increasingly important. Currently, there are approximately 1012 Demeter-certified wineries worldwide, of which 438 are located in France. Outside the European Union, most wineries are located in Switzerland, the United States, Chile, and Argentina. In total, about 15.000 hectares of the Demeter-certified area are biodynamic vineyards. Also, Demeter banana is a very dynamic sector at the moment.

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UNIT 2:

LEGISLATION, CERTIFICATION and POLICIES

INTRODUCTION

It is given an overview of the organic legislation and standards, with partiular reference to the new EU Organic Regulation, listing its main principles. Other Organic International Standards are mentioned, including the IFOAM standard for organic production and processing and Demeter standard for orgnaic-biodynamic production systems.

Organic certification is described in its main process and activities distinguishing third party certification with participatory guarantee systems. Then the IFOAM PGS is described including services of recognition and promotion put in place by IFOAM OI.

Finally, main organic policies are noted, with references to the EU Rural Development Programs support policies and to the recent EU Farm to Fork Strategy, where organic farming is targeted to triple its present dimension to reach 25% of all EU agriculture land by 2030. In addition, a brief overview of rural development and organic agriculture in Turkey was given.

1. Organic Legislation and Standards

1.1. EU Organic Regulation (848/18)

On 1 January 2022, the new EU Regulation 834/18 came into full effect, defining the new rules for the production, labeling and controls of organic products. After defining the specific requirements and prescriptions for the different types of production in the basic text of the regulation and in some delegated acts dedicated to livestock production, the regulatory framework was completed with the Commission Implementing Regulation (EU) 2021/1165 of 15 July 2021.

In the transition between the two Community Regulations there were no important changes for the zootechnical sector except in the field of poultry, rabbit and deer reared in Northern European countries for which it was necessary to integrate or define the rules for raising these animal species organically.

1.1.1. EU Organic Regulation Principles

The basic principles on which organic animal husbandry is based are defined in the recitals of the Community Regulations, the key points that characterize the thinking are listed below:

- ✓ Farming without land is not allowed, the animals on an organic farm have a functional relationship with the land which requires the manure produced to enrich the farm land from which the food for their sustenance will be produced.
- ✓ The ratio is such as not to exceed 170 kg of N ha/year.
- ✓ In the breeding of animals, breeds that have the ability to adapt to local conditions and are resistant to diseases should be preferred.
- ✓ Animal welfare is the basis of organic livestock farming: the animal must be reared with the possibility of being able to express the needs of the species.
- ✓ It is necessary to guarantee the use of pasture or open spaces for the animals raised whenever the climatic conditions allow it.
- ✓ Mutilations are prohibited.
- ✓ Health management must be aimed at disease prevention, the use of veterinary drugs is allowed but not for preventive purposes, the use of hormonal substances aimed at synchronizing estrus is prohibited.
- ✓ The animals must be fed with foods grown organically, therefore GMO foods are prohibited.
- ✓ The power supply must come mainly from the company itself for at least 60%, calculated in dry matter on annual consumption if polygastric (70% from 2025) and 20% (30% from 2025) if monogastric are reared.

- ✓ In herbivores the daily ration must consist of at least 60% forage.
- ✓ The feeding of young mammals must take place with natural milk or its substitutes that will not contain proteins of vegetable origin.

1.2. Other Organic International Standards

Europe and other relevant National legislations on organic agriculture and animal breeding, around the entire world take reference from two main sources:

Codex Alimentarius Committee (a joint FAO and WHO) published guidelines for the production, processing, labeling and marketing of organic produced food, which formulated the guidelines adopted for herbal products in 1999. The guide was revised in 2001 to include provisions on livestock and livestock products. Codex instructions are optional; member states can choose to what extent they follow them.

IFOAM Organics International that with its series of IBS Ifoam Basic Standards first published in 1985 have been used as reference form many organic associations for the development of their voluntary standard, but also from many Countries in developing their organic legislation.

1.2.1. IFOAM Standard for Organic Production and Processing

The IFOAM standard pays particular attention to respecting the ethology of species, reinforcing the idea that animals must be raised in the possibility of being able to express the needs of the species. Grooming for cattle is a fundamental behaviour that has a fundamental social function. Pig rooting involves the possibility of searching for food by digging into the soil.

The IFOAM standard also strongly reaffirms importance and the need to ensure daily access to grazing areas with all the animals present on the farm to ensure their proper movement and access to green food that is particularly welcome and important for its nutritional contribution.

Table 1. Main differences between EU organic regulations and IFOAM Standard

ISSUE	EU REGULATIONS	IFOAM STANDARD
Control of insects	Use of insects traps and pyrethroids	Preference of Phisical methods (traps etc.)
Bedding	vegetable	Organic vegetable
Grazing	When possible	In season always for all animals

Milking animals conversion	6 months	Whole gestation in organic system
Mutilations authorization	Veterinary authorization	Veterinary authorization and anesthetic if heated iron is used for dehorning
Vaccinations allowed	Always	Allowed only if motivated by a veterinarian
Suspension time for medicines	Double the normal	Double the normal, but not less than 14 days
Transport to slaughterhouse	No prescriptions	Maximum 8 hours

1.2.2. Demeter Standard

The Demeter specification establishes the basic principles that combine organic production with biodynamic ones. The rules governing animal husbandry are particularly important since the presence of animals in all biodynamic farms is considered essential for the need to create an agricultural organism in which the plant and animal kingdoms are functional to each other. For the biodynamic method, it is important to promote soil fertility not only with agronomic practices but also with the contribution of organic matter from farmed animals. At the same time, the food necessary for animal nutrition will be produced on the land.

The animal, as a being that lives only in the sphere of emotions, depends in a particular way on human care. To respect its nature, the fundamental objective of daily action should be to give it all the necessary care and at the same time create the possibility for it to develop in a way that conforms to its being.

The Demeter specification also pays great attention to the fact that animals have access to the outdoors in order to stay in contact with the world to which they belong: nature. Therefore, the possibility that animals can choose to be in contact with sun, rain, wind, are important requirements for animal sentience.

Due to the biodynamic method, the presence of hornless animals in breeding is not allowed except for those breeds such as Aberdeen Angus which are animals without horns.

The feeding of the animals must be supported by foods obtained with biodynamic methods (at least 60%), for the remaining part of the ration it is possible to use organic food. In the feeding of herbivores, the presence of green grass must always be present, compatibly with the seasons, and forages must make up at least 75% of the ration.

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For fertilization, the introduction of males into the farm is desirable even if artificial insemination is not prohibited.

1.3. USDA National Organic Program (NOP)

A federal norm began to develop in the field of organic farming in the USA in 1990, which later became the United States Department of Agriculture's National Organic Program.

The Organic Food Production Act (OFPA) and NOP were implemented in 2002. This law ensures that all food products labeled organic in the US are managed by consistent standards. NOP's requirements for labeling apply to raw, fresh products and processed products containing organic farming ingredients.

Agricultural products that are sold, labeled or specified as organic must be produced in accordance with NOP standards. And these products must be processed according to NOP standards. Farm and processing operations which grow and process organic agricultural products have to be certified by USDA-accredited certification agents, except for operations with a gross income of $5,000 or less from organic sales. These certification providers and the USDA work together to enforce their standards. These accredited certification bodies work together to provide a level playing field for producers and maintain consumer confidence in the integrity of the USDA Organic Seal.

1.3.1. NOP Labelling

Labeling requirements are based on the percentage of organic ingredients in a product. There are four different labeling options based on the percentage of organic ingredients in a product. These fall into three different categories. There is also a fourth option for products that contain organic ingredients but are not sufficient to meet one of the three labeling categories:

100 percent organic: A label stating that it has been produced exclusively by organic methods is affixed. And only products containing organic ingredients (excluding water and salt) are allowed to carry a label stating they are "100 percent organic."

Organic: This label indicates that at least 95 percent of the ingredients (by weight, excluding water and salt) in a processed product are organically produced.

Other ingredients may only consist of natural or synthetic ingredients recommended by the National Organic Standards Board. Or natural or synthetic ingredients not found in the organic form permitted on the National List are acceptable. This product cannot use both organic and non-organic versions of any ingredient listed as organic at the same time. For example, if a loaf of bread is made from organic wheat, all of the wheat in the bread must be made of organic ingredients, and non-organic ingredients cannot be included.

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Made by Organic ingredients : Labeling products with 70-95 percent organic content may include the message “Organic ingredients [three specific organic ingredients or food groups listed]” on the front panel.

- ✓ All three categories mentioned above, strictly prohibits the inclusion of components produced using genetic engineering, irradiation or sewage sludge.
- ✓ Products with less than 70 percent organic ingredients can only display organic ingredients in the ingredient panel.
- ✓ There can be no mention of organic on the main panel.
- ✓ There is absolutely no mention of organic expression in the main panel.

USDA has designed a seal which can be used only on products labelled as “100% organic” or “organic” to assist consumers. Use of this seal is voluntary, but it is a useful tool. Grocery stores are using the “USDA Organic” seal on shelf talkers and other point of purchase materials to identify organic sections in the store. Non-food products which meet the requirements of using the “USDA Organic” seal can use the seal, too.

1.3.2. NOP Main Difference with EU Organic Regulations in Animal Rearing

In summary, the salient point is the ban on the use of antibiotics in the milk production phase and if an animal in production is treated with an antibiotic, that animal cannot be certified NOP. In addition, animals that were treated within the twelve months before entering milking will not be able to enter organic production before the expiry of the twelve months. Example: a 5 months pregnant heifer that is treated and calves after 4 months of treatment, can only be certified 8 months after delivery.

There is an equivalency agreement between the European Union organic regulations and the USDA, but the NOP criteria on the ban of antibiotics use it is maintained.

1.4. JAS Japanese Agriculture Standard for Organic

The JAS Standards for organic plants and plant-derived organic processed foods were established in 2000. These standards are based on the Guidelines for the Production, Processing, Labeling and Marketing of Organically Produced Foods adopted by the Codex Alimentarius Commission.

The organic JAS system has been enhanced with the addition of standards that went into effect in November 2005. The contribution of the JAS Standards for organic livestock products, organic processed foods of animal origin and organic feeds has a great role in this development.

Operators accredited and qualified by registered Japanese or overseas certification bodies may affix the organic JAS logo to products produced in accordance with the relevant organic JAS Standards.

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The equivalence between EU organic regulations and JAS standard is not recognized for the livestock part. Consequently, operators that apply for JAS certification for animal products (meat or cheese) must have the entire supply chain certified in accordance with the JAS standard starting from the feed mill.

If it is not possible to find JAS certified feed, organic certified feed can be used in countries with which there is an equivalence agreement with Japan (e.g., European Union) as long as the certificate specifies the name and address of the control, date of issue of the certificate, type and quantity of certified feed, name and address of the operator, indication of the grading activity.

It is not possible to certify live animals: the control bodies cannot issue the JAS certificate with the indication "dairy cattle" or "sheep" or "beef cattle", control bodies will issue a document certifying the compliance of the company with JAS standards, which must be sent to the customer, e.g. slaughtering industry, to which, after verifying the requirements, the JAS certificate can be issued. The criterion is that JAS certification only applies to food products.

2. Organic Certification

The organic certification process is a certification process that is valid for organic food producers and also valid for other organic agricultural products producers. In general, any business directly involved in food production can be certified, such as seed suppliers, farmers, food processors, retailers and restaurants.

The requirements for this certification process vary from country to country. The process often involves a set of production standards in cultivation, storage, processing, packaging and transportation, including:

- ✓ Absolutely avoiding the use of synthetic chemical inputs. (for example, fertilizer, pesticides, antibiotics, food additives). Also avoiding the use of irradiation and sewage sludge.
- ✓ Avoidance of use of genetically modified seeds.
- ✓ Use of farmland free of chemical inputs that were banned a long time ago (usually three or more).
- ✓ Regarding livestock, to produce based on special requirements for shelter, feed and reproduction, and to adhere to these requirements.
- ✓ Keeping detailed production and sales records in writing (audit follow-up).
- ✓ Ensuring strict physical separation of organic products from non-certified products.
- ✓ Periodic on-site inspections of the facilities.

In EU and many countries, the certification process is overseen by the government. Thus, the commercial use of the term organic is legally restricted. Certified organic producers are also subject to applicable agricultural, food safety and other government regulations; just like non-certified manufacturers.

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2.1. Third Party Certification

In the third-party certification process, the processing stages of the farm or agricultural product are inspected and certified. This process is certified by an accredited organic certification body in accordance with national or international organic standards. One of the key requirements for certification is that the farmer typically engages in a range of new activities in addition to normal farming activities:

- ✓ Compatibility — Farm facilities and production methods must comply with the following standards: Standards such as changing facilities, identifying and changing suppliers, etc.
- ✓ Documentation — The necessary documents should be available to identify the farm's past activities. It is also a must to have comprehensive paperwork detailing the Farm's current layout and often containing the results of soil and water tests.
- ✓ Planning — There should be a written annual production plan where everything from seed to sale can be checked in detail:
- ✓ Seed sources, field and crop locations, fertilization and pest control activities, harvesting methods, storage locations, etc.
- ✓ Inspection — Physically checking facilities, examining records and conducting oral interviews are important requirements for annual audits. The vast majority of inspections are carried out in the form of scheduled visits with prior notice.
- ✓ Fee — The annual inspection/certification fee applicable to these inspections must be paid. (current price in EU 400–2,000 Euro per year, depending on the certification body and the size of the operation). Many EU countries have financial aid schemes to qualify for certified operations.
- ✓ Record keeping — Records covering all activities should be available in writing. These records should be available for review at any time.
- ✓ In addition, short-term or unannounced surprise inspections and specific tests (exp: soil, water or plant tissue) may be requested.

The certification process for non-farm operations follows a similar set of processes. But here, too, the focus is on the quality, processing and processing conditions of the components and other inputs used in production. A shipping company will need to report in detail the use and maintenance of its vehicles, storage facilities, containers, etc. When a restaurant business or butcher allows their facilities to be inspected, their suppliers are verified as certified organic.

2.2. Participatory Guarantee Systems

Participatory Guarantee Systems (PGS) emerge as an alternative to third-party certification specifically tailored to local markets and short supply chains. They can also supplement third-party certification with private labels that provide additional guarantees and transparency. PGS offers terms suitable for the direct participation of producers, consumers and other stakeholders for the followings:

- ✓ Selecting the standards and making the definitions of these standards.
- ✓ Development and implementation of certification-related procedures.
- ✓ Making certification decisions.

2.2.1. IFOAM PGS

"Participatory Guarantee Systems (PGS) is one of the quality assurance systems focused more on local areas. PSGs certify Producers based on the active participation of stakeholders. And they are organizations built on a foundation of trust. They continue their activities based on social networks and information exchange"

IFOAM - Organics International supports the development of PGS as an alternative and complementary tool to third-party certification in the organic sector and advocates for the recognition of PGS by governments. IFOAM OI is collecting, compiling and publishing worldwide data about PGS initiatives.

Whether a PGS initiative is operating in accordance with Key PGS Aspects and Characteristics is assessed through the official IFOAM PGS Recognition programme. And so this recognition program validates the integrity of PGS against the Principles of Organic Agriculture.

The evaluation process is carried out free of charge from beginning to end and is implemented with the support of the IFOAM PGS Committee. PGS initiatives that receive the IFOAM PGS Recognition are granted access to the IFOAM PGS Logo to use in communication materials such as websites and brochures. However, this logo cannot be used on products. PGS initiatives officially recognized by IFOAM – Organics International – are specially highlighted on the – IFOAM Global PGS Enterprise Map.

3. Policies

3.1. EU Rural Development Programs Support Policies

Since the first agri-environmental programs of the EU regulation 2078/92 it was included reference to organic farming and consequently many national implementing programs since as early as 1993, started supporting organic farms, including livestock ones, with CAP financial resources mainly provided in the different National or Regional Rural Development Plans.

Nowadays in most EU countries there is an action plan to promote the diffusion of organic agriculture and support is available to support its practices' introduction and maintenance in EU farms. In most reginal or national programs, the support is based on hectares of crops and if organic animals are raised, often an increase of premium per forage or pasture land.

3.2. New 2020 EU Strategy Farm to Fork

In 2021 the Commission published and the EU Parliament approved a ne strategy for food and agriculture "Farm2Fork", that aims to accelerate transition to a sustainable food system that should:

- ✓ Having a neutral or positive environmental impact.
- ✓ To help mitigate climate change and adapt to its effects.
- ✓ Reversing biodiversity loss.

There is a strong commitment toward organic farming, setting the target of **25% organic land by 2030.**

The F2F strategy foresees a budget of €49 million for organic farming, inter alia, within the framework of promotional policies. In addition to this budget, it plans to take concrete steps to increase organic demand through integration of organic products into the minimum mandatory criteria for Green Public Procurement (GPP). Additionally, given the importance of knowledge in organic food systems, dedicating at least 30% of Horizon Europe funding for agriculture, forestry and rural areas to organic sector related issues is an important step forward.

In March 2021, the commission published the new Organic Action Plan (OAP) 2021-2027, which was well received by the organic sector, mainly due to its push-pull approach, aimed at balancing increases in both production and demand for organic products.

3.3. A Brief Overview of Rural Development and Organic Agriculture in Turkey

Turkey implemented social and economic development process into practice in the 1930s. Services and Investments taken to villages can be examined in two periods: "pre-planned period" and "post-planned period" studies in terms of economic processes and planning. To minimize and eliminate the difficulties of life in rural settlements since the establishment of the Republic; Enactment of the Village Law, agricultural reform and land management, land registry and cadaster regulations, agricultural equipment activities, village institutes, farmer training, and agricultural extension services, village development, community development, agricultural cooperatives, rural services, irrigation, and in-field development services, integrated rural Various policies and practices such as development projects, regional development projects, and rural development support programs have been implemented. In this context, legal and institutional structures were made and a considerable amount of public resources were allocated. Considering that approximately one out of every four people in Turkey currently lives in rural areas, it can be said that agriculture and rural development policies maintain their importance in every period.

The Ministry of Agriculture and Forestry is responsible for the coordination of rural development studies and supports in Turkey. In the 19th article of the Agriculture Law No. 5488, rural development supports are thoroughly discussed. According to this article: The Ministry takes some measures in this regard; These measures can be listed as developing agricultural and non-agricultural employment in rural areas, increasing and diversifying incomes, raising the education and entrepreneurship levels of women and young population. It makes arrangements regarding rural development programs, projects, and activities and ensures coordination among public institutions. In rural development programs, projects, and activities; participation, bottom-up approach, development, and institutionalization of local capacity are the fundamental principles. Prominent activities in support of rural development mentioned in the Agriculture Law; Rural Development Investments Support Program, IPARD (Instrument for Pre-Accession Assistance Rural Development) programs are integrated rural development projects conducted with the support of young farmers and loans provided by international organizations.

Turkey's rural development policy is affected not only by local internal dynamics but also by international developments. When rural development supports are examined:

- ✓ The IPARD (Instrument for Pre-Accession Assistance Rural Development) program, created by the EU to support candidate and potential candidate countries in the pre-accession process, stands out. Turkey, which started accession negotiations in 2005, receives funds from the agriculture and rural development component of IPA for alignment with the acquis under Chapter 11, titled "agriculture and rural development." For this purpose, IPARD programs have been prepared by the Ministry of Agriculture and Forestry for the 2007-2013 and 2014-2020 financial periods and have been approved by the European Commission.
- ✓ One of the activities put into practice in the field of rural development in Turkey in 2016 is the support program for young farmers. With the Support for Young Farmer Projects Program, it is aimed to ensure sustainability in agriculture, support the entrepreneurship of young farmers, increase their income levels, create alternative income sources and support agricultural production projects that will contribute to the employment of young people in rural areas.
- ✓ One of the support programs carried out in rural areas with national budget resources is the Rural Development Investments Support Program. This program was initiated by the Ministry of Agriculture and Forestry in 2006 within the scope of the National Agricultural Strategy Document. The beginning of the program aims to encourage and support investments in economic activity of real and legal persons in the form of individual and group applications and investments in the rehabilitation of existing infrastructure facilities of organizations to ensure economic and social development in rural areas.
- ✓ Another activity in rural development supports is integrated rural development projects. The Ministry of Agriculture and Forestry aims to improve the economic and social welfare of the rural population with these projects, which it has been carrying out since the 1970s with the support of loans from international organizations.

Table 2. Outsourced Rural Development Project

Project name	Project period	Project sponsor	Project amount
Completed projects			
Çorum – Çankırı Rural Development Project	1976-1984	World Bank	161,6 Million ABD$
Erzurum Rural Develepment Project	1982-1990	World Bank – IFAD	137 Million ABD$
Agricultural Extension and Application Project	1984-1997	World Bank – IFAD	351 Million ABD$
Bingöl – Muş Rural Development Project	1990-1999	IFAD	52,5 Million ABD$
Yozgat Rural Development Project	1991-2001	IFAD	40,5 Million ABD$
Eastern Anatolia Watersheds Rehabilitation Project	1993-2001	World Bank	110 Million ABD$
Ordu – Giresun Rural Development Project	1995-2006	IFAD – Islamic Development Bank	59,70 Million ABD$
Agricultural Reform Implementation Project	2001-2008	World Bank	661 Million ABD$
Anatolian Watersheds Rehabilitation Project	2005-2012	World Bank	27,95 Million ABD$
Sivas – Erzincan Development Project	2004-2014	IFAD – OPEC	30,04 Million ABD$
Diyarbakır – Batman – Siirt Development Project	2007-2015	IFAD	37 Million ABD$
DOKAP Agriculture Project	2007-2014	JICA Technical Cooperation	5 Million TL
Ardahan – Kars – Artvin Development Project	2010-2018	IFAD	26 Million ABD$
Coruh River Basin Rehabilitation Project	2012-2019	JICA	111 Million TL
Murat River Basin Rehabilitation Project	2012-2019	IFAD	38,48 Million ABD $
Ongoing projects			
Göksu - Taşeli Basin Development Project	2015-2023	IFAD	22,27 Million Avro
Rural Disadvantaged Areas Development Project	2017-2023	IFAD	35 Million Avro

- ✓ The "Women Farmers Agricultural Extension Project" constitutes the locomotive project of the works carried out for women in rural areas by the Ministry of Agriculture and Forestry. This Project aimed to disseminate agricultural innovations to increase the quality and productivity in agriculture through women farmers and to raise awareness.
- ✓ In cooperation with the Ministry of Agriculture and Forestry and the United Nations Food and Agriculture Organization (FAO), a series of projects have been implemented to ensure the development of local gender-sensitive extension services and gender-based data. These are "Developing the Capacity of Rural Women in Socio-Economic Aspects with a Gender Perspective for Sustainable Rural Development" (Turkey-Azerbaijan) and "Creating Gender-Disaggregated Data and Strengthening National Capacities through the Implementation of the Gender and Agriculture Framework Program" (Turkey, Tajikistan, Kyrgyz Republic) projects.
- ✓ One of the most crucial obligations of Turkey in the international arena is the regulations it has made in the process of full membership to the European Union. In Turkey's EU accession negotiations, studies on agriculture and rural development are carried out

within the framework of chapter 11 “Agriculture and Rural Development.” Within the scope of the chapter, agricultural support mechanisms, which are the primary elements of the EU Common Agricultural Policy, regulations on agricultural products markets and rural development policies, and administrative structures and control systems for their implementation are discussed. Within the scope of this section, progress has been made towards compliance with organic agriculture legislation, institutional capacity in this regard has been strengthened, organic agriculture standards have been established with the Organic Food and Agriculture Action Plan. With the Regulation on the Principles and Implementation of Organic Agriculture issued on August 18, 2010, Turkey’s organic agriculture legislation has been harmonized with the EU organic agriculture legislation. In addition, agriculture-environment, climate, and organic agriculture issues are included in the measures within the scope of IPARD I (2007-2013) and IPARD II (2014-2020) programs approved by the European Union Commission.

There are 2 organic agriculture projects carried out for many years by the Ministry of Agriculture and Forestry in Turkey.

- ✓ **Gökçeada and Bozcaada Agricultural Development and Settlement Project:** It is aimed to increase agricultural production by making the best use of the existing natural resources in Gökçeada and Bozcaada districts, and to create an active and settled population by increasing the income levels of the farmer families who have been or will be resettled in the islands. Studies were started in 1993. The agricultural part of the project has been implemented since 2001. It is envisaged that the project will continue until the goals that form the basis for the project are achieved. The project includes; Development of organic olive and olive oil production, organic beekeeping and honey production, organic viticulture, organic fruit and vegetable production, development of cattle and ovine farming, development of fisheries and aquaculture, dissemination of medicinal and aromatic plants, training and publication activities for producers and consumers.
- ✓ **Dissemination and Control of Organic Agriculture Project:** The project aims to spread organic agriculture, to support the production of organic products that all income groups can consume, to establish traceability, to operate an efficient control and certification system, and to raise consumer awareness about organic products. The project has been implemented since 1997, and the studies in 2020 were carried out with 24 provincial Directorate of Agriculture and Forestry and 5 research institutes under the coordination of the General Directorate of Plant Production. In 2021, it will be carried out together with 28 Provincial Directorate of Agriculture and Forestry and 5 Research Institutes.

Especially along with the 2000s, environmentally friendly non-governmental organizations operating in the field of agriculture and forestry in Turkey have started to be active. In addition to these organizations, consumption cooperatives that can establish a direct food chain relationship with producers have begun to be established in city centers and some universities. Ecological life, organic agriculture, and food safety have come under the interest of a much greater number of academics and researchers. Research centers on rural development have been opened in the academy.

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UNIT 3:

ECOLOGY

INTRODUCTION

Ecology general principle is explained first with its etymology and definition, then the IFOAM Organic Agriculture Principle of Ecology it is reported with its strong statement: “Organic farming should be done according to living ecological systems and cycles. Organic agriculture should work with the mentioned ecological systems, be developed according to them and help to maintain them.”

The principle is declined in the IFOAM standard chapter 5.1. Animal Husbandry General Principles: “Organic animal husbandry is made as a whole of harmonious relations between soil, plant and animal husbandry elements.”

This leads to a correct relationship between land and animals to avoid environmental impacts such as overgrazing, nitrates pollution, greenhouse gases emission.

Finally animal husbandry positive contribution to organic farming systems are listed, as well as examples of grazing pastures as prevention of wood expansion, fires, land erosion and flooding.

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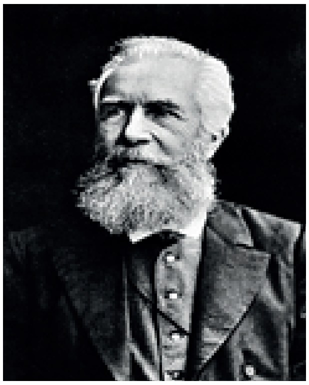
1. General Principle

1.1. Ecology and Definition



Ecology (Greek: οἶκος, "home" and -λογία, "study") is the set of systems in which the relationships between living organisms, including humans, and their physical environment are evaluated. Ecology studies organisms at the community, population, individual, ecosystems and biosphere level.

The word "ecology" ("Ökologie") was coined in 1869 by the German scientist **Ernst Haeckel**[1], and it became a rigorous science in the late 19th century. Ecology, studies the followings among other things:

- ✓ Assessing life processes, interactions, vulnerability, and adaptations.
- ✓ The study of the movement of materials and energy through living communities.
- ✓ Sequential development of ecosystems.
- ✓ Intraspecies and interspecies cooperation, competition and predation.
- ✓ Abundance, biomass and distribution of organisms, taking into account the environmental factor.
- ✓ Study of biodiversity patterns and their impact on ecosystem processes.

Ecosystems are systems of organisms that interact dynamically, the communities that these systems form together, and the inanimate components of their environment. Ecosystem processes as primary production, nutrient cycling, and niche building form their own system by regulating the flow of energy and matter through an environment. Ecosystems have biophysical feedback mechanisms. This mechanism is the biophysical feedback element that governs processes affecting the living (biotic) and non-living (abiotic) components of the planet. Ecosystems maintain life-supporting functions and provide ecosystem services such as biomass production (food, fuel, fiber, and medicine). In addition, ecosystems contain climate regulation, water filtration, global biogeochemical cycles, soil formation, control of erosion, flood protection, and many other natural charecteristics of scientific, historical, economic or intrinsic value.

1.2. IFOAM Principle of Ecology

"Organic farming should be based on living ecological systems and ecological cycles. Organic farming should work functionally with ecological systems and help sustain them."

1 Ernst Haeckel's photo was taken https://en.wikipedia.org/wiki/Ernst_Haeckel.

This principle has an important function because it roots organic farming within living ecological systems. It states that production should be based on ecological processes and recycling systems.

Nutrition and well-being are achieved through the development of a particular production environment and the resulting ecology. For example, in the case of crops, this refers to living soil; for animals, the farm is an ecosystem; For fish and marine organisms, the aquatic environment refers to an ecosystem.

Organic farming, pastoral and wild harvest systems should be done in accordance with the cycles and ecological balances in nature. The cycles are universal, but their operational dimensions are specific to each site. Organic management have to be adapted to local conditions, ecology, culture and scale, and environmental factors. To protect and improve environmental quality and conserve resources, reuse, recycling and efficiency of materials and energy are of paramount importance. Because in this way the inputs should be reduced.

Organic agriculture should attain balance in ecology by designing farming systems, establishing habitats and maintaining genetic and agricultural diversity. The ones who produce, process, trade, or consume organic products should protect and benefit the common environment which include landscapes, climate, habitats, biodiversity, air and water.

2. Correct Relationship between Land and Animals

The above principle is translated for organic livestock breeding in the IFOAM Standard for organic production and processing chapter 5.1. Animal Husbandry General principles:

“Organic livestock is the whole of harmonious relations between soil, plant and livestock. Organic Livestock is based on respecting the physiological and behavioral needs of livestock and using quality organically grown feeds.”

2.1. Environmental Impacts

If this relationship is not well balanced it may lead to some environmental impacts of animal husbandry.

2.1.1. Overgrazing

Excessive grazing that causes a depletion of the turf, compromising its development, in fact when the grass becomes less than 5 cm in height, the plant is unable to make the best use of the chlorophyll photosynthesis function and consequently, it has difficulty in growing regularly. For this reason, it is essential to observe the pasture and to intervene at the right times to avoid excessive grazing. There are various grazing techniques to avoid overgrazing:

- ✓ Adequate density of animals according to the period and the terrain, for example in the mountain pastures of Northern Italy a general criterion of a LU/ha is used.

- ✓ Shifted pasture, that is to divide the land into several plots and use them in a shifted manner, following the principle of minimum grass height.
- ✓ Rational grazing, is a system that involves dividing the land into several small plots, so that the group of animals is moved on a daily basis, allowing the turf to grow back faster, more specifically with the following possible options: A) day 1 dairy cattle, day 2 replacement heifers; B) day 1 dairy cattle, day 2 beef sheep, day 3 poultry.

2.1.2. Nitrates Pollution

The good health of the soil is expressed in its being a living ecosystem that sustains and nourishes plants, animals and humans. From this statement comes the importance of managing and taking care of the land so that it can continue to represent a sustainable resource for future generations.

The effluents that are produced in a livestock farm (sewage, manure, urine) due to their nitrogen content are excellent amendments but can represent a problem for the environment when we do not have a correct relationship between the animals raised and the land in which such produced excrements are distributed. Agriculture, in fact, is accused of being the main source of nitrate pollution (deriving from both farms and mineral fertilizations), which by not remaining in the ground for long, percolate and pollute the aquifers and, subsequently, the seas.

In particular, in sewage the ratio between carbon and nitrogen is lower than that of composted manure and consequently have a higher polluting charge. For this reason, floors that lead to the production of sewage only are not allowed in organic livestock farming.

Faced with these problems, the European Community in 1991 issued the "Nitrates Directive", with the aim of reducing water pollution caused by nitrates of agricultural origin. Each Member State has the duty to identify the Vulnerable Zones from Nitrates of agricultural origin (VZN), i.e., those areas characterized by waters that are already polluted or that have a high risk of becoming so. In these areas, for each company or farm, the quantity of effluent spread on the ground every year, including the one distributed by the animals themselves, does not exceed a certain quantity per hectare, which corresponds to the quantity of effluent containing 170 kg. of nitrogen. This threshold, on the other hand, is mandatory for all organic farms regardless of where they are located.

2.1.3. Greenhouse Gases Emission

The emission of methane (CH4) in ruminants is an absolutely physiological fact and the result of a millenary evolution that has led these animals to live in mutualistic symbiosis with microorganisms (bacteria and protozoa) capable of digesting the fibrous fractions of food, for the benefit of the host animal. Today, however, a growing part of public opinion, often ill-informed, points to animals in livestock production as the main culprits of the climate changes underway (global warming due to greenhouse gases) precisely and above all due to methane emissions. The methane attributable to animal husbandry derives from enteric fermentations (rumen + large intestine, 85%) and from those involving manure (about 15%).

2.1.4. Methane and Global Warming

According to the estimates of the Intergovernmental Panel on Climate Change (IPCC, 2014), agriculture, including animal husbandry, contributes to the emissions of climate-altering or "greenhouse gases" (GHG, Green House Gases) of anthropogenic origin and therefore to global warming (GWP, Global Warming Potential) of the planet for 14%. Again, according to the IPCC, among the GHGs (CO2, CH4, N2O and F), methane contributes to global warming of the planet by an average of 18%. These values refer to the CO2-equivalents (CO2-eq) since the different gases have a specific greenhouse effect; in particular, referring to a time span of 100 years, methane is worth 25 times the CO2 and nitrous oxide (N2O) 300 times the CO2.

Finally, the contribution of agriculture to world emissions of methane (anthropogenic and non-anthropogenic) is on average 40% and of this around 70% is attributable to animal husbandry, including enteric emissions and those from livestock waste. We can therefore calculate that in terms of methanogenesis, animal husbandry is responsible for about 5% of the GWP worldwide.

2.1.5. Rumen Methanogenesis

In the anaerobic environment of the rumen, carbohydrates, fibrous or not, are degraded to pyruvic acid and subsequently to volatile fatty acids: acetic (C2), propionic (C3) and butyric (C4), often present in the form of their respective salts (acetate, propionate, butyrate). These are then absorbed through the ruminal wall and enter the bloodstream thus providing energy to the ruminant. However, there is a substantial difference between the production of acetate and butyrate on the one hand and the production of propionate on the other: the first releases hydrogen ions (H +) in the rumen, the second subtracts them. In the absence of oxygen, the final H + receptor is carbon, resulting in the formation of methane. Therefore, the production of methane increases as the ratio between C2 + C4 and C3 increases. Since methanogenesis requires the presence of H +, the substrates (hemicellulose and cellulose) that favour acetic and butyric fermentation will favour methanogenesis, while those (starch and pectin) that favour propionic fermentation will tend to reduce the production of methane.

It has long been known that diets based on cereal seeds reduce the emission of methane (expressed in g/kg DM ingested) compared to diets based on fodder. However, it should be remembered that the advantage of ruminants is their ability to convert fibrous sources that are unusable by humans into noble proteins such as those of milk. A compromise may be to feed dairy cattle with medium/high starch content with the dual purpose of increasing the energy of the diet (and therefore the production level) and reducing the emission of methane per kg of DM ingested or milk.

Ultimately, if we evaluate the methane emission not in absolute value (g/day or kg/year) but relative (g/kg milk, kg/t milk), it is advisable to provide a sufficiently energetic diet, with digestible fibres and starch, to increase milk production and dairy efficiency (kg milk/kg SS ingested), both inversely related to methanogenesis expressed as CH4/kg milk produced.

Equally interesting is another study that publishes the research conducted by a group of scientists from the University of Otago, New Zealand, a country where this problem is very acute. Researchers think it is possible to mitigate the emission of agricultural greenhouse gases by directly acting on the production of methane in the rumen of animals. The claim is supported by their discovery of those microbes and enzymes that make it possible to produce methane in the body of animals by controlling the supply of hydrogen which is the main source of energy for the microbes that produce methane, called microbes methanogens. The work, published in the International Society for Microbial Ecology Journal, is the first showing the mechanism behind the microbes that produce methane in the digestive system of animals. The researchers came to the discovery by analysing two species of sheep quite different in terms of methane production: the first species produces little and the second high quantities. They found significant differences in particular species of microbes that are more active in consuming hydrogen. They have identified various species that absorb hydrogen in different ways. This is a discovery that lays the foundations for new strategies regarding the reduction of gas emissions by farm animals: by controlling the supply of bacteria that produce methane, their number and consequently the quantities of gases they produce.

3. Animal Husbandry Positive Contribution to Organic Farming Systems

- ✓ Providing Manure for the soil fertility cycles allowing more complex and efficient crop rotations.
- ✓ Enhancing biodiversity of the whole farm agroecosystem.
- ✓ Allow a better use of marginal land and pasture.

4. Grazing Pastures Area as Prevention of Wood Expansion, Fires, Land Erosion and Flooding

Throughout the European Alpine arc, in recent decades there has been a reduction in the number of livestock farms and a consequent abandonment of the most marginal mountain agricultural land, with a progressive reforestation of lawn and pasture areas. This phenomenon of secondary succession, for which, in areas once cultivated, new woods are being developed, is seen by many as a positive fact that balances the serious phenomenon of deforestation that is occurring in developing countries where, for some time now, the progressive destruction of large areas of tropical forest has been witnessed.

On the contrary, the reforestation of pasture or meadow areas in mountain areas leads to negative consequences in many respects. In the environmental field, there is a loss of biodiversity of all those plant species that need open environments, with the disappearance of those herbaceous and shrub associations that need light for their development. In the animal field, there is a lower availability of food as well as for the avifauna, with a consequent decrease of the same, also for the livestock species, a phenomenon that leads to the purchase by mountain farms of fodder and materials extraterritorial firsts. Another negative effect from an environmental point of view is the increased risk of hydrogeological instability due to the fact that the lawns managed extensively and with reduced shrub cover, are characterized by a moderate loss of soil. On the contrary, in the presence of shrub cover, erosive phenomena with high superficial flow occur more easily, potential causes of flooding downstream with the danger of landslides and floods. Furthermore, in drought periods or areas, the danger of fires is obviously much higher in wooded areas rather than in pasture areas.

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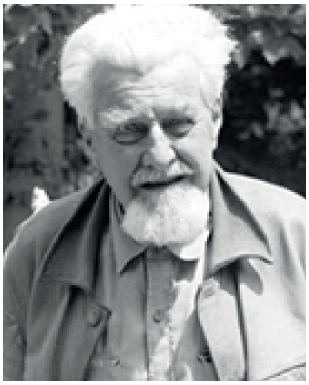
UNIT 4:

ETHOLOGY

INTRODUCTION

The observation of animal behaviour has always been the subject of studies and insights by many researchers who, by observing animals, try to discover their behaviours and characteristics.



The founding father of this discipline is recognized by all to be **Konrad Lorenz**[1], an Austrian zoologist who devoted many years of his life to the study of animal behaviour. For a breeder or for a technician who provides advice on a farm, it is essential to have an in-depth knowledge of the characteristics of an animal.

In a period in which animal welfare becomes an increasingly topical subject due to the criticism that intensive farming receives from public opinion and from consumer, talking about a topic such as animal ethology becomes fundamental.

In fact, it is only through the knowledge and study of the animal that management techniques can be implemented on the farm that allow the animal to be able to express the behaviour of the species, one of the 5 freedoms indicated in the Brambell Report of 1965.

The animal is a sentient being, or an individual capable of experiencing sensations. We human beings have a responsibility when we bring them up: to make them experience positive sensations and a right present. In fact, animals live identified in the present, they do not have a conception of the past, they remember only by reliving what they feel in the present and they do not even have a chance to create an image of the future that is an exclusive prerogative of man. In order to work on this right present, it is therefore essential for us to know how a bovine sees or what kind of hearing a pig has. Or it is equally important to know that the sheep is a grazer that differs from a goat that prefers shrub pastures completely different from those needed by the sheep as a grazer. The knowledge of ethology therefore lays the foundations for making an animal feel good which, deprived of the stress that it can feel when living in conditions not suitable for it, grows without getting sick and improves its production performance and consequently increases the profitability for the breeder.

In this chapter, was therefore consider some of the main ethological characteristics of cattle, pigs, sheep and goats, trying to create a more realistic image of the animals mentioned that can help breeders and technicians in their daily work.

1 Konrad Lorenz's photo was taken https://tr.wikipedia.org/wiki/Konrad_Lorenz.

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1. Ethology General Principles

1.1. Ethology and Definition

Ethology (n.) late 17c., "art of depicting characters by mimic gestures, mimicry", from Latin ethologia, from Greek ēthologia, from ēthos "character" (see ethos). Mill took as "science of character formation" (1843); as a branch of zoology, "study of instincts", from 1897.

Ethology is defined for different animal species as per their behaviours mainly in terms of their way of feeding and way of reproduction: herbivorous with or without a rumen/ (carnivore)/ omnivorous – mammal – oviparous, but also in their ways of social relations, for example the sheep is a gregarious animal, its social attitude is living in a flock, not as single individual.

1.2. Why Ethology is Important?

Description of the animal = with the Lisbon Treaty of 2008, it was accepted that animals are creatures that capable of feeling. Article 13 of Title II states: Article 13 of Title II states that: "In formulating and implementing the Union's agriculture, fisheries, transport, internal market, research and technological development and space policies, the Union and the Member States shall, pay full regard to the welfare requirements of animals, while respecting the legislative or administrative provisions and customs of the EU countries relating in particular to religious rites, cultural traditions and regional heritage, since, animals are sentient beings."

When the animal cannot express its spices ethology it is under stress that bring it to an immune depression status increasing pathologies outcome

More pathologies = more medicines use = more antibiotic resistances (about 800.000 deaths per year in the world)

Organic livestock principles and rules avoid the systematic and/or preventive use of allopathic practices. For this reason, respect for animal ethology is very important when doing organic livestock breeding.

The European Union has recently implemented the Organic Regulation 848/18 (01.01.2022). This regulation clearly refers to animal ethology.

-in the considering (44):

Organic animal housing conditions and livestock practices must meet the behavioral needs of animals. In addition, certain aspects of animal housing conditions must ensure a high level of animal welfare beyond the Union animal welfare standards applicable to livestock production in general.

-in article 5, General principles:

Organic production is a sustainable management system whose principles are based on the following general principles:

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(a) respect for nature's systems and cycles and the sustainment and enhancement of the state of the soil, the water and the air, of the health of plants and animals, and of the balance between them;

(j) the observance of a high level of **animal welfare respecting species-specific needs**.

IFOAM Standard is referencing animal ethology in chapter 5.1 Animal Husbandry General principles: Organic livestock farming is generally based on the harmonious relationship between soil, plant and livestock. Organic livestock farming is based on respect for the physiological and behavioral needs of livestock and the use of quality organically grown forages.

2. Bovine Ethology

2.1. Definition and Origin

The rumen herbivorous mammals consisting of a diverse group of 10 genera of medium to large ungulates, which includes domestic cattle, bison, buffalo, water buffalo, and four-horned and spiral-horned antelopes, are called Bovines (subfamily Bovinae). The evolutionary relationship between members of this group is still debated, and their loose classification by species rather than formal subgroups is an important factor reflecting this uncertainty. Common features include twin hooves and at least one of the sexes of a species that usually has true antlers.

Bovine milk and meat represent the basic food consumption of people in many countries. Bovines are kept as livestock almost everywhere except in regions of India and Nepal, which are considered sacred by most Hindus. In addition to all these benefits, bovines are used as pack animals and riding animals.

Small domestic bovine breeds such as the Miniature Zebu are kept as pets.

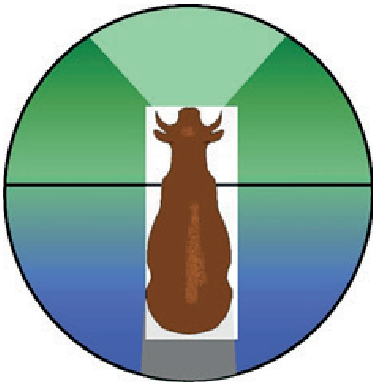
According to a genetic study about the bovines, it is assumed that all modern domesticated cattle descended from a single herd of wild oxen that lived 10,500 years ago.

2.2. Physiological Characteristics Sight, Smell etc.

When comparing the brains of other animals and that of humans, the only difference evident to the naked eye is the larger size of the neocortex in humans. Inside the neocortex, the frontal lobes are the final destination of all information transmitted to the brain, where it is brought together in a single overview. The other animals, however, all the tiny sensory details that come from the environment, remain separate and identifiable.

The price humans pay in exchange for their highly developed frontal lobes is a level of inattention not found in animals. "Human beings are abstract not only in the way they think, but also in the way they see and hear. Animals don't see their own idea of things: they see real things. This is the big difference between humans and animals who use sensory language."

2.2.1. Sight



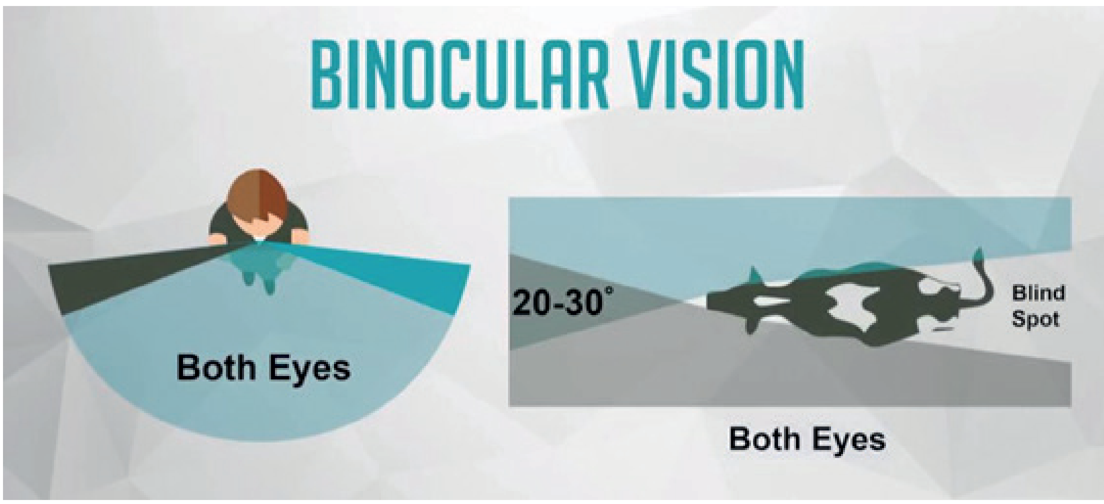
For cattle, as for us, sight is the dominant sense, from which they get about 50% of the information from the environment. However, cattle see differently from us: they have a 330° vision, mainly lateral monocular at great distances, being a preyed animal, this allows them to graze and ruminate for hours while keeping the surrounding territory under control. Binocular vision is a limited area in front of them and this should be taken into consideration as it limits their ability to perceive depth or distance. Keep in mind that the three-dimensional vision, which allows the animal to understand the real distances from an object, a person or another animal is limited only to a short distance in front of the eyes, otherwise the sight does not allow a bovine to understand the real distances.

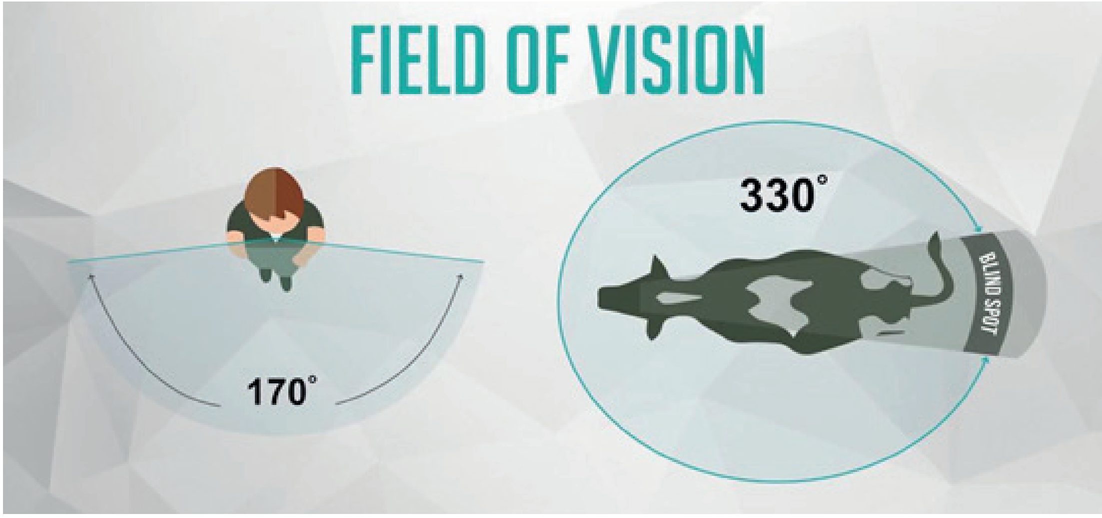
Binocular vision

Clear vision up to the back Reduced vision behind the back

Blind spot

Knowing the visual field is important, for example, to approach them correctly, i.e., from the side and slowly, thus avoiding fear and therefore fickle and unpredictable behaviours. Even during handling operations, it is essential to take into account that we and the cows have a different field of vision and, therefore, we see different things.





Source: DairyNZLtd

Cattle only see a small area in front of them and cannot gauge distance and depth well. Certain passages or gate configurations can conflict with a cow's depth perception making the animal difficult to move efficiently. For example, a cow will not understand an opening at right angles to the end of a corridor and the animal will avoid being moved in this direction since it does not perceive an escape or return route.

Due to their limitation in vertical vision and the lack of ability to focus quickly, it is important that there are no obstacles (real or presumed) in its path and in case allow the cow time to lower her head, focus. the obstacle and proceed again.

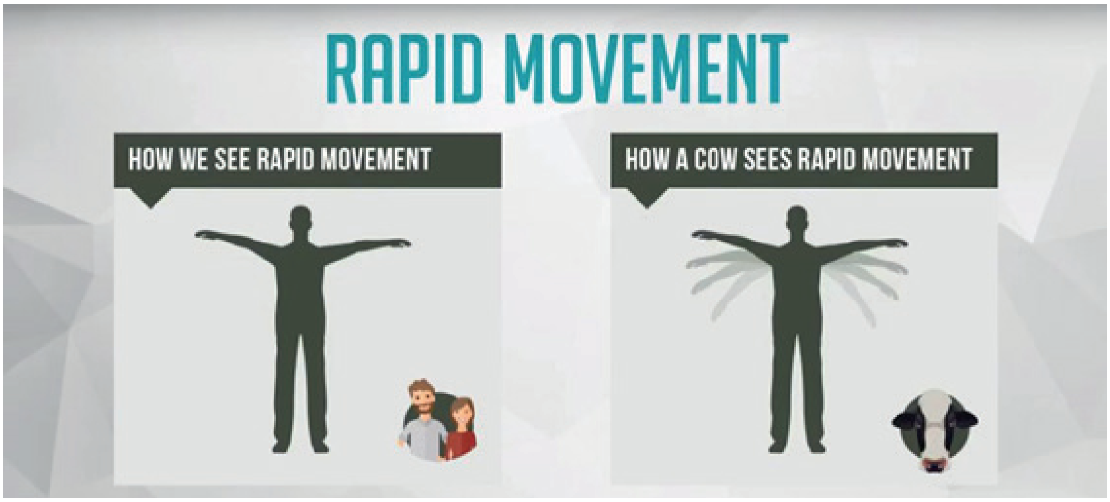
Even in this case, however, we must take into account that their perception of an obstacle is different from ours! For example, a shadow on the ground could be mistaken for a deep crevasse! Due to their "crepuscular" life, therefore more active at sunrise and sunset, they are very sensitive to light, are dazzled by intense light and are afraid of bright contrast: they are less able to discriminate objects that differ in intensity of light and cannot see the colour contrast, they perceive the more extreme shadows than we perceive them.

They have dichromatic vision, being able to distinguish colors of longer wavelengths (yellow, orange, and red) much better than shorter wavelengths (blue, gray, and green). Calves can distinguish between long (red) and short (blue) or medium (green) wavelengths. However, their ability to distinguish between short wavelengths and medium wavelengths is limited. As far as possible it is therefore good to maintain uniform lighting, reduce contrasts and reflective surfaces. For example, during a handling operation, lights reflecting on puddles can represent a disturbing element sufficient to frighten the animal and prevent it from moving forward. Furthermore, this sensitivity to light stimuli is to be taken into consideration due to the difficulty of focusing in the dark/light transition. The transition from illuminated areas to shaded areas requires an adjustment period of a few minutes, which the farmer must take into account when moving the animals. The reverse phenomenon is faster: cattle are attracted to light if it is not excessively dazzling. In a condition such as the photo below in the transition from a dark to a very bright environment it takes a few minutes to adapt the view. If the contrast is particularly strong, the light dazzles them making them almost blind for a few minutes. It is obvious that in these conditions the animals are frightened and freeze for this reason: screaming or making them move by force is counterproductive, it is better to wait a few moments for the vision to adapt and allow them to spontaneously resume the movement.

Night vision: man-bovine

Day vision: man-bovine

Another curiosity related to vision is their perception of movement: the perception of dynamic movement is distorted so they are afraid of rapid movements that have a great effect in activating the amygdala, the part of the brain that controls fear. It is therefore good to move with slow movements so as not to scare them and not to be perceived as potential predators.



Source: DairyNZLtd

Finally, sight is involved in social and physiological aspects. All breeders know that isolated cows suffer, they are social animals that need eye contact with their peers, since they are preyed upon animals the sense of the group reassures them. In addition, sight is involved in reproduction: the pineal gland records the length of days through sight, in the dark melatonin is produced which has a stimulating/inhibiting effect on the secretion of GnRH (Gonadotropin releasing hormone) to allow births in spring.

2.2.2. Hearing

Cattle perceive a wider range of frequencies than humans, so even for hearing we must take into account that they hear sounds differently from us and they perceive more of them than we do. They are very sensitive to the high frequencies that scare them, while the low frequencies calm them.

Cattle are animals that are constantly alert, they are constantly listening. Continuous listening is instinctive, they have better hearing at low frequencies which allows them to hear sounds at great distances and to identify predators in time to get to safety. High-pitched noises and intermittent sounds such as clanging metal (e.g., gates), yelling, whistling, and music can be particularly stressful, especially if they are sudden and loud yelling has the same stressful and fearful effect as an electric goad.

They recognize the human voice and are able to identify operators; some sounds, if inserted in a serene relationship with the breeding system, can orient the cows and be associated with moments of the day, facilitating some operations.

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They take longer than us to locate the source of the sound: they identify better if the origin is placed at an angle of about 25-30 degrees, otherwise they will tend to orient the head differently.

The perception of sounds and therefore the vocalizations are also inserted in the social dynamics of the group. Animals through vocalizations can signal the physiological or emotional state, motivations and intentions. For example, they use low frequency mooing when waiting for food, milking or to call the calf, higher frequency in a frustrating situation, for example when a cow is isolated and high intensity is that of a threatening bull or a starving calf. The calf also recognizes the mother by the mooing and the calls.

2.2.3. Smell

The sense of smell is highly developed, cattle are able to distinguish some substances in much lower concentration gradients than humans and have the ability to perceive odours up to 8 km away. They can’t stand the smell of saliva and faeces, in fact in the pasture where they defecate, the grass is not eaten. In addition to the olfactory bulb, cattle have the vomeronasal organ (responsible for the flehmen, head up and lip curled) responsible for olfactory communication:

- ✓ Sexual recognition through pheromones.
- ✓ Maternal recognition within the herd.
- ✓ Peculiar smell of faeces and urine in case of fear.
- ✓ Choice of food and how much to consume (particularly evident in the pasture when the animal is guided by the sense of smell for the choice of essences to ingest).

From the first minutes after giving birth, the mother recognizes the calves through the sense ofsmell and establishes the maternal bond.

2.2.4. Touch

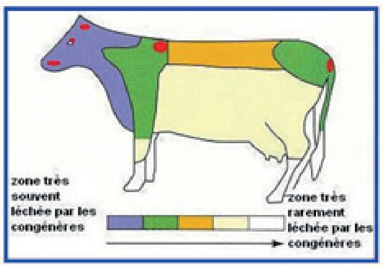

Figure 8: Areas licked by fellow animals (SAMBRAUS, 1969).

The sense of touch is developed both in the perception of contact with the environment, with another animal or with man, and during grazing activity to evaluate and choose a food before tasting it: cattle use the muzzle to explore as man uses his fingertips!

Tactile perception occurs through rubbing and scratching. Within the group, the cattle have a particular behaviour called grooming which consists in licking their own coat or that of the conspecifics, it is used to clean

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themselves and as a cohesive group activity to strengthen bonds, especially the maternal one. It has a calming and gratifying effect on the heartbeat.

2.2.5. Taste

Cattle are able to recognize 5 tastes: sweet, salty, sour, bitter, umami. Sweet is very appetite like salty, they signal the presence of substances that are not naturally present in their diet such as simple sugar and sodium.

2.3. Horns, Why to Keep Them?

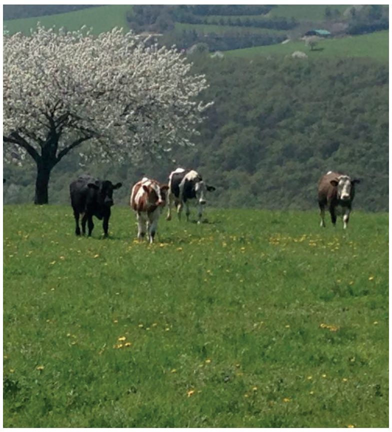
Some considerations from a biodynamic perspective

2.3.1. Distinguishing Characteristics

Their horns allow cattle to reach a much longer size compared to the compactness of their bodies. The cow's appearance has a specific character thanks to its horns. The clear vision capacity of a cow is limited to about 10 meters in a 60° vision frame. Because they have this type of field of view, anything further away than cows can only be perceived in terms of outline and movement. Cows which have no horns as calves generally have eyes set closer together than those with horns. Therefore, hornless cows tend to focus more strongly forward than horned cows, and their rearward viewing angle is relatively limited.

2.3.2. Holding Their Own Place in the Herd's Hierarchy

The person watching the grazing cows will soon become aware of the individual relationship between one cow and another. This relationship is a friendly one, but at the same time, it's clear that cows respect hierarchy. In every pack, there is a hierarchy accepted by each of its members. However, the position of cows in the hierarchy must be constantly rearranged. Hierarchy manifests itself in the dominant behavior of the higher-ranking animals, in the behavior of the lower-ranks, as well as in the struggles between them. The oppressive behavior has a more hostile appearance. You'll find that animals form friendlier relationships when they graze and rest or lick each other. Trying to keep the flies away, they approach each other and often stand alone with each other. Both types of behavior can be exhibited by the same animals at different times.



Less obvious, but still influenced by hierarchy or pecking order, is the distance between one cow to another. The amount of physical space each animal needs is greatly affected by whether it has horns or not. In horn cattle, the required physical distance between animals above and below the hierarchy ranges from one to three metres. In hornless animals, the situation is the opposite. Hornless animals need a meter at most. This void, which bubbles around each animal symbolizing an invisible physical space, is known as its "individual distance." Encroachment on this area will either lead to escaping animals lower in the hierarchy or to a struggle between animals. Horned animals of the same age almost always have a higher hierarchy than hornless animals. Older animals normally have a higher hierarchy than younger ones. Problems seldom arise among horn cattle in the pasture. In free-hold conditions, however, fights and fights between horned cattle can be quite frequent, especially if the space is tight. This causes stress and a higher risk of injury. Serious injuries from antlers occur especially in the udders or vaginas of animals. However, it is possible for a herd of cows to survive as a more peaceful horned herd even under more limited conditions. A good relationship between the cows and the minimum number of changes in the population lead to the peaceful living of the herd.

In generally dehorned cattle are quieter under loose housed conditions than horned ones, because their individual distance is smaller. Frequent injuries caused by head butting thoughtless outwardly visible, can occur also among dehorned cows. To avoid having a fight animal in confined housing conditions generally don't move very much. It was observed how in an average sized loose housing situation the animals moved about for less than 2% of the day, but out on the pasture they would spend 12–15 % of the day in movement. Cows at pasture will cover some 4 to 10 km per day but those indoors rarely exceed 0,3 to 4 km.

When fights occur between animals, the horns are used to counter an attack or change the direction of the attack. In addition, they are often used to hold heads together, prevent heads from slipping, and allow a head-to-head strength trial to occur. It cannot be said that the horns function as "weapons" in this case. Hornless animals cannot repel each other; their heads slide when they bump into each other; and they have to interfere with each other from the side. They cannot conduct their struggles in a species-specific way. Young males especially seem eager to playfully bang their horns together. Young male cows cling to their horns and rub their foreheads against each other's foreheads. Or they move their still small horns towards each other. Adult animals also enjoy a friendly, playful antler lock or mutual scratching with them.

Cows exhibit grooming behavior with their antlers – for example, cows use antlers to scratch their backs. Or they can use their horns to scratch and clean their own eyes from the horn of another cow. Every animal has a knowledge of the size of its horns, and animals are certainly aware of the shape of the horns and where they end. The horns also give the cow an idea of its hierarchical place in the herd.

2.3.3. Digestion and Metabolism in Connection with Horns

Since all horned animals also ruminant, we can assume that they have highly developed digestive organs. It can also be assumed that there is a connection between their digestive systems and their horns. However, there is not much research on this subject. Rudolf Steiner in the Agricultural Course provides information on this link. Since then, many biodynamic farmers have attempted to make their own observations of the link between horns and metabolism. The cow is quite successful throughout the digestive process. Because, until now, transforming cellulose into something useful with so little energy has not been accomplished with a man-made device. Cows also do this at low cost. The digestive organs of ruminants are completely arranged in accordance with the transformation of cellulose. The "normal" digestive system (mouth-larynx-stomach-duodenum-small intestine-additional-large intestine-rectum) is formed during embryonic development in such a way that the three anterior stomachs formed from the esophagus are located in front of the small intestine, which is the main absorption organ. All of the pre-digested cellulose material, along with bacteria, yeast and microbes living in the rumen, is digested in the abomasum and small intestine and provides an important source of protein. This kind of digestive system occurs only in ruminants. In all other cellulose-consuming species, such as horses and rabbits, the nutrients to be digested pass through the small intestine and are broken down by microorganisms living in the large intestine, producing a lower quality end product. The most important processes of metabolism in ruminants occur in the most prominent part of the organism, the part of the body where most animal sensory activity predominates - rumination and fermentation of cellulose. The frontal weight of the body and horns helps limit this "force of forward motion". This is highlighted by the fact that the growth of the horns is in the form of an inward-curving spiral focused around a central point. These digestive processes enable animals to produce a benefit that promotes humus formation. At the same time, this digestion process produces milk for human consumption and fertilizer for growing plants. Cows give birth to a calf almost every year and meet our meat needs. This level of performance can only be achieved through the cow's specific organism. The characteristic features of a cow's life are determined accordingly. Cows spend two-thirds of each day either eating or ruminating. Their senses are not awake when viewed from the outside, but are directed towards their own body. They often appear to be dozing off while ruminating. At the same time, their heads are turned upwards, but focused inward. While ruminant animals perform their chewing activities, they "consciously" perform a metabolic activity; this special movement is something other animals and humans do only when they are eating. Ruminants actively decide when they want to start rumination and stop rumination when disturbed. During the rumination process, chewed food moves back and forth between the dark, anaerobic, slightly acidic environment of the rumen and the lighter, oxygen-rich, alkaline environment of the mouth. It's not just about the movement and transformation of nutrients, but also about their strength. The horn is able to capture the forces escaping from the digestive processes, directing them back into the animal's organism. This recycling system and concentrate method is an important element that contributes to the enormous metabolic capacity of the cattle. The digestive and metabolic function of antlers (as well as hooves) is therefore more about strength than food.

2.3.4. Breathing

Two openings through which the cow makes contact with the world are the nose and mouth. Each breath brings air from outside into the nose. Its mucus membrane makes it warm and moist. Any particulates collect on the moist surfaces and are subsequently expelled. The cow's very large paranasal sinuses increase the mucus membrane area and in extending into the horn's bony core, form an important part of the immune defence of the breathing system. With the in-breath air coming from the sinuses is carried on the breath and drawn into the lungs, lowering pressure in the sinuses at the same time. With the out-breath air of the lungs passes through the nose together with gases of rumen rising from the throat, enters and increases pressure in the sinus system. In breathing in and out the air passes over that zone of the nasal mucus membrane where the olfactory receptors are located. This is where the smells maintained the in and out breath are perceived.

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2.3.5. Disbudding and Dehorning

Except the risk posed to farm personnel, it is the transition from tethered to loosen housing that brought the issue of horns into sharp focus. The suggested and allowed dimensions of the loose housing are generally so tight that cows are unable to avoid one another and often end up in fights. Because this leads to frequent injuries among the animals, the dehorning of loose housed cattle came to be suggested. In emergency conditions when the injuries can not be tolerated, even the adult cows' horns are removed. At 1970s and 1980s when loose housing was being introduced, it was widespread practice for the horns to be sawn off under anaesthetic using thick steel wire. The separating and dehorning bleeding vessels were closed and the sinus cavities were occluded with a tampon. Thus, the wounds of the cows are gradually closed. In some cases, cows regrow horns. Dehorning using such a method is rarely practiced today. It is now usual for calves to have buds cut before they are four weeks old. In Switzerland bud cutting with abrasive iron (700 °C) has to be done under local anesthesia by trained professionals. And it is imperative that this method be practiced so that it causes as little stress as possible. In Germany, antlers of calves are allowed up to six weeks of age. In the UK, calves must be dehorned within the first two months of life by a trained person under local anesthesia. Intervention is painful. The calf may feel pain for two or three days or longer after the anesthetic wears off. But wounds heal quickly. The removal of the horn has a noticeable influence on the form of the developing skull. On attaining adulthood most dehorned animals will have developed a marked bulge on their foreheads. When we look at the interior of a bony skull, we find that this bulge – like the horn's bony core – is filled with air spaces. The animals likely need a certain capacity of sinus cavities and have to compensate for the lack of horns to develop this bony protuberance. An examination of more than 230 skinned cattle skulls immediately after slaughter shows that a high proportion of the skulls of dehorned animals have a bulging forehead. Moreover, the frontal bones' shape of dehorned animals were more concave, were drawn forward and there was less distance between the eyes. Animals with horns generally had flat (especially towards the top) or slightly arched frontal bones and a wider distance between the eyes. The fact that the animal reacts to the removal of a few area of skin with such a big change in skull development, indicates that cattle definitely need their horns and have to compensate by transforming their frontal bones.

2.4. Feeding, Including Pasture Characteristics

Cow grazing ruminants, their ethology is to feed mainly through grazing, having the choice of the feed by their own. Grazing is not only for feeding, but it puts the animal in direct contact with nature: its colours, its sounds, its odours, the sun, the wind and rains. It gives the animal chance to move and fulfil its ancestral behaver. Biodynamics philosophy and breeding systems, consider these factors as fundamental to connect the animal to the other kingdoms and the horn play a role of interconnection with cosmic universal forces.

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2.5. Giving Birth and Milking

2.5.1. The Natural Relationship between Cow and Calf

A common practice is to separate calves from their mothers on the first or second day of their life so that mother cows can be milked regularly. Then, the calves are fed twice a day with fresh cow's milk from the udder buckets. This method is often tried and generally positive results are obtained. However, this method prevents the development of a natural connection between the mother and the calf. Here are some information that can be used when working with animals; Some important information about mother-bound and protective calf rearing methods has been tried in the field. It is not enough just to have knowledge about the natural behavior of animals in this type of dairy farming. It is also important to know how to assess the essential and non-essential aspects of animal husbandry and the potential for animals to adapt flexibly. In addition, the farmer needs to develop a new approach in modern style to work with his/her animals.

Farmers tried to find a suitable alternative system that predicted a natural relationship between dairy cows and calves. Information based on these experiences will be presented here.

2.5.2. The Natural Behaviour of Cows and Calves

What events occur during natural calving? What kind of behavior do cows and calves exhibit after calving? If it is considered to be allowed; How often, for how long, at what intervals and how exactly should a calf be breastfed? Knowledge and understanding of the anatomy and physiology, as well as the natural, species-specific behavior of cows and calves, provide an important basis for decisions about calf rearing method. Anatomy knowledge is important for decisions about maternal-bound and protective calf rearing, as well as motherless calf rearing. The following information and descriptions have been compiled from textbooks on animals living in a farm environment, as well as wild and semi-wild animals. In addition, the source of this information is observational studies.

2.5.3. Around Calving

A few hours before calving, cows normally seek a quiet, dry location further away from their herd and slightly higher. They breed in open areas without buildings or settlements, sometimes close to their flocks. The choice of where to calve also differs for each cow.

Cows should be taken to a specially designed shelter for calves shortly before calving if they do not want to leave the herd. Shortly after calving, the cow begins to lick its calf intensely. During this process, the cow makes some deep, wheezing bellows. The cow usually starts to eat feed after birth. The calf can usually stand 10 to 30 minutes after birth. The calf starts looking for the cow's udder to suck milk 45 to 95 minutes after birth. All healthy calves can stand and start suckling within three hours. If they do, it allows them to absorb valuable colostrum. At this very important and necessary stage, the calf's mother's recognition and a kind of stigmatization takes place; after that, the cow now recognizes its calf. It is also possible to print with a calf from another cow. If the cow does not show this behavior, it may be necessary to support the calf in some way by helping it find the teats and sucking. If a cow needs to feed a calf, the best time to introduce and stamp it is shortly after calving.

In the first hours and days following calving, the cow keeps to lick the calf intensely, thus strengthening the bond between cow and calf. If the cow does not lick this voluntarily, she invites the calf to suckle. After about 3 days, the cow and the calf recognize each other by their voices. Even the cow recognizes the calf by its smell. However, they do not always know each other by appearance. Some cows are aggressive towards humans at this stage. If the calf has to be separated from the mother before a bond is formed, it is necessary to separate the calf within the first 24 hours after birth. In addition, the mother's licking has positive effects on the calf's blood circulation.

2.5.4. 1 to 14 Days after Calving

During this period, the calf needs more rest. The calf suckles about 6 to 8 times a day for an average of 7 minutes. It mostly sucks from one or both breasts. When the mother leaves the calf to feed, some calves stay in a secluded place. Then the mother returns to lick and breastfeed the calf. Mature cows begin to leave their calves alone earlier than younger cows. However, some calves follow their mothers to the herd from the second day of their lives (this is especially true for animals living in the open). In such cases, the cow prefers to be alone with her calf at the edge of the herd. Depending on the calf's structure, the newborn calf can be left alone in the calving cage for a long or short time. This allows the cow to be fed and milked in the calving cycle. For the calf's health, the cow must have access to the calf several times a day.

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2.5.5. 2 to 8 Weeks after Calving

During this period, the mother accompanies the herd with her calf. The calf joins the other young calves. Calves are usually guarded by a cow or bull. The mother cow grazes with the other cows. Calves rest, play and play. The mother cow normally calls her calf to suckle, and sometimes just to check it's there or lick it off.

Cows only lick their calves. They usually only let their calves suckle. Other calves without calves are usually removed quickly. Cows suckle their calves in an inverted parallel position. Also, cows recognize their calves by smell. Calves also make an effort to suck milk from other cows.

They do this from the back, preferably while the cow is sucking its calf. The reason they approach from behind is to avoid the usual odor identification process. Occasionally, calves call their mothers when they are hungry. The mother cow usually reacts and moves towards the calf, while the calf runs to meet it. Calves suck for about 10 minutes, 4 to 5 times a day over time. During this period, the cow's aggression towards humans decreases. Groups of calves should be kept in a separate place in the barn. Thus, temporary separation of mother cow and calf is now easily possible. Not all cows are appropriately built as guard cows. Calves will suckle without any problems if guard cows allow it. Foreign calves are best accepted by the cow while simultaneously suckling its own calf. For the health of the calves, they should be given the opportunity to suckle for a total of about 50 minutes several times a day.

2.5.6. 2 to 5 Months after Calving

Calves become more and more integrated into the herd. However, they still like to play with calves their own age; During this period, calves take part in activities such as playing, running in groups, and playfully fighting. Male calves use their horns to play-fight with each other. Male calves fight jokes more often than female calves. Calves often play with their mothers. Sucking times and frequencies are at the same level as in the first weeks of life. Calves of similar age should be kept together and have enough room to play and have fun. Calves at this age range still need about 50 minutes of suckling time per day.

2.5.7. 5 Months after Calving and Subsequently

After nearly 5 months, the calves start to graze with the adult animals, usually right next to their mothers, and tend to display similar behaviors as they do. At about 8 to 9 months of age, the mother cow will wean her heifer calf, but weaning of a bull calf will delay until it is 11 to 12 months old. The close connection between mother cow and calf continues after weaning and after the birth of sibling calves. Compared to unrelated animals, related ones graze together and lick each other more often. The mother cow and siblings are the primary social partners of the lower-ranking young animals. Although still so young, weaning of a calf is allowable from the age of 5 months. To separate mother and calf will cause feelings of loss for both animals, and it is critical to offer enough distraction to the animals after separation.

2.5.8. Anatomical and Physiological Aspects

From the first few minutes of age, the calf has a strong sucking reflex that is triggered when the oral mucosa is touched; This strategic feature turns into a chewing reflex as the calf ages.

On the chemoreceptors, warm milk triggers reticulum contractions that lead to the formation of a closed groove between the esophagus and abomasum, so that milk flows directly into the abomasum instead of passing through the rumen (chest) first. The calf will not have developed its own immune system at the beginning of its life. Calves receive the necessary immunoglobulins with colostrum. Calves suckling from their mothers take in more globulin than those fed from a bottle, as their globulin is broken down very quickly and some is lost in the period between milking the cows and feeding the calves.

The amount of globulin in milk decreases continually after birth. However, the calf will have developed its own immune system more regularly after 4 weeks. Therefore, the risk of disease in calves is highest at 2 to 4 weeks of age. The calf should be given the opportunity to breastfeed frequently because it cannot satisfy this reflex and this need in any other way. The calf should receive warm milk, as it perfectly triggers reticulum contractions. The calf should suckle from the very beginning, preferably from its own mother. All calves 2 to 4 weeks old should be treated with extreme care (good hygiene, stress avoidance!) to prevent disease.

2.5.9. Systems of Mother-Bonded Calf Rearing

Depending on the milk system and equipment used, the characteristics of the herd, and the preferences of the farm management, a variety of maternal and protective calf rearing systems may be preferred. Three systems can be distinguished that go beyond the common practice of short-term suckling from the mother cow during the colostrum phase:

- ✓ Prolonged, restrictive breastfeeding with additional milking: Cows and calves are brought together twice a day specifically for suckling. Usually the mother cow allows her own calf to suckle, but this can be arranged so that other calves can suckle as well.
- ✓ Long-term breastfeeding with unlimited access and extra milking: cows and calves are in contact with each other for several hours a day or unrestricted contact. In addition, cows are milked 1-2 times a day. Usually the mother cow breastfeeds her own calf, but this can be arranged so that other calves can also suckle.
- ✓ Long-term lactation without additional milking (full lactation period): Cows are permanently associated with 2-4 calves each. There are always foreign calves around, so cows are guard cows. After a short lactation period, only the mothers of foreign calves are milked. Foster cows can be milked again after weaning or in the next lactation period. Other Differences in Management Especially in the first system, there are many different ways cows and calves meet each other.

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- ✓ Meeting time: before milking, after milking.
- ✓ Time interval between reception and milking: just before milking, just after milking, eg. one hour before milking, eg. an hour after my milking.
- ✓ Meeting place: the cow goes to the calf. The calf goes to the cow. Cow and calf meet in the exercise yard or waiting room for cows.
- ✓ In addition, weaning is possible in several ways, such as:
- ✓ A. Calves suckle from their mothers until they are weaned.
- ✓ B. Before the calves are weaned, they are separated from the mother.
- ✓ B1. Calves suckle from a foster cow after leaving from the mother.
- ✓ B2. After separation from the mother, the calves suckle from a bucket or automatic calf feeder.

3. Pig Ethology

3.1. Definition and Origin

Pig is a mammal and omnivorous social animal. The domestic pig originates from the Eurasian wild boar (Sus scrofa). Some evidence by sequencing of mitochondrial DNA and nuclear genes from wild and domestic pigs in Asia and Europe provided evidence that domestication occurred independently of European and Asian wild boar subspecies. The time elapsed since ancestral forms diverged was estimated to be around 500,000 years, well before domestication about 9,000 years ago.

3.2. Social Structure and Habits

Pig is a social, intelligent and curios animal, with a strong character. It is a particularly sensitive and emotional animal. It has a great enemy: stress!

It is a gregarious animal that lives in small matriarchal family groups through very stable relationships that are formed already at weaning. Males join the group for mating. It lives in the home-range: group territories that include areas for rest, grazing, defecation, mud pools, connected to each other by paths.

It loves to spend most of the day lying down napping, an activity to which it spends up to 19 hours a day. To rest, it chooses a dry and sheltered place with a good possibility of vision and control of what is around.

It is a clean animal that takes care of its body through mud baths in order to thermoregulate itself and remove skin parasites. It uses trees and shrubs to scratch itself, as it can't reach much of the surface of the body with its limbs.

The pig is an animal with a crepuscular diurnal activity that is very sensitive to light contrasts: it therefore has a tendency to move towards a brighter area as long as the light does not hit the eye directly.

3.3. Physiological Characteristics Sight, Smell etc.

Pigs have an extraordinary ability to learn (it seems comparable to a three-year-old child); the more we know of the way in which they receive stimuli from the surrounding environment, the more we will be able to interact with them avoiding unnecessary sources of fear and pain.

Furthermore, stimulating the different senses constitutes a kind of cognitive enrichment that could play an important role in improving the quality of their life.

3.3.1. Sight

Pigs have a lateral monocular vision of approximately 310°, a binocular vision of approximately 35-50° and a blind spot above the back. The 310° panoramic vision, typical of predated animals, allows a lateral view without moving the head, this means that, compared to humans, they have the ability to use each eye separately, a means of survival useful in searching for food and detecting possible dangers. They do not quickly settle down and cannot focus easily: operators must move in a way that effectively communicates what is being asked of them. When handling and/or interacting with them, this lateral view must always be kept in mind, since openings or other disturbing elements that do not fall within our field of vision could instead be at the centre of theirs. It is therefore advisable to create closed sides to contain the walkways and loading/unloading chutes.

On the other hand, the reduced bifocal vision and the limited ability to focus, make it more difficult to calculate distances and perceive depth. They have a large blind area at ground level and to judge the depth on the ground they have to stop and lower their heads. This too must be taken into consideration. For example, they are likely to confuse floor irregularities and shadows with real physical barriers, or we may see pigs trying to fit into spaces that are too tight for them.

Pigs have dichromatic vision and see mainly red, green and blue wavelengths. Up to 12 lux are able to distinguish colours, while under 1.5 lux they see in black and white; below 0.2 lux they lose vision. They tend to see solid colour; for example, they can see the blue sky, but do not perceive the clouds.

They hesitate and flee in the face of new visual experiences: for example, the transition from a solid concrete floor to a grating.

Starting from these considerations, the farm environment can be made more comfortable and less stressful. For example, they will see an operator arrive if he wears red, green or blue boots much better than black or brown boots.

In the context of human-animal interaction dynamics, it has also been shown that they are able to recognize and remember some of our facial expressions and respond accordingly.

Unlike us humans, sigh for pigs it is not the dominant sense and they receive information from the surrounding environment mainly from smell and hearing.

3.3.2. Smell

Pigs have a well-developed sense of smell through which they collect most of the information from the environment around them and the changes that occur there. The olfactory bulb in pigs represents about 7% of the brain size, while in humans it is about 0.01%.

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The sense of smell is also decisive in relations with conspecifics: recognition of belonging to the herd, individual recognition in the group, reproductive activity (detection of pheromones), etc. Furthermore, the sense of smell conditions the first post-weaning food preferences and, even before that, guides new-borns to the breast, representing one of the main discriminators for attachment to the nipple and the establishment of the maternal bond.

Having a much more developed sense of smell than humans, they will also be more easily disturbed or stressed by new smells or odours that are unpleasant for them: for example, cigarette smoke, the smell of petrol or naphtha.

Finally, the sense of smell and their exploratory nature must be taken into consideration during handling operations since, not being able to count on visual abilities, they should be given the opportunity to smell the path to understand where they are going.

3.3.3. Hearing and Vocalizations

Even very sensitive hearing compensates for poor vision. Noises that are harmless or not perceived for us, can be so annoying to them that they damage their hearing system: their perception of sounds varies from 42 Hz to 40.5 kHz with a better sensitivity from 250 Hz to 16 kHz; they are also able to perceive ultrasounds.

For this reason, loud or high-pitched noises, prolonged exposure to noise, as well as human cries represent a source of stress and fear and can therefore lead to both visible injuries from sudden movements and aggression, and non-visible injuries to the acoustic organ.

When entering in their places, it is therefore important to try to remain silent without slamming doors or gates, so that the pigs do not associate loud and unpleasant noises with their handlers. On the contrary, pleasant sounds can be associated with daily operations and facilitate their execution.

Auditory stimuli are in fact widely used by pigs as a means of communication in all social activities: vocal signals are probably the main means of communication; they emit and recognize about 40 different sounds that express different moods. The sow calls the young to feed with a special grunt. The vocalizations also serve to maintain the stability of the group and consist of simple grunt, staccato, long, bark and high-pitched squeal.

For example, the bark is emitted by the frightened animal while the shrill screech when it is hit or restrained. The vocal response of the pig is scientifically related to an emotional state (and therefore of well-being) that can occur during the different stages and operations of breeding, such as, for example, fear, isolation, pain, anticipation and frustration.

3.3.4. Taste and Touch

The pig is omnivorous, it loves to hunt small mammals and root by eradicating herbs and roots: it dedicates about seven hours a day to searching for food, during which it can travel up to 50 km: THE PIG NEEDS EXPLORATION AND GRUFULATION!

3.4. Tail and Teeth, Why are They Relevant?

The pig's tail as an indicator of stress when is bitten. The is teeth functional for grazing and for defence (baits) being a predated animal.

"An intact and curled tail could be the single indicator based on the animal, the most important for assessing the welfare of weaning, growing and fattening pigs" certifying "High management quality and respect for the integrity of the pig."

"Tail biting is considered an abnormal behaviour. It has a multifactorial origin but the main cause is considered to be the need to exert an exploratory behaviour. Tail biting is associated with frustration and it is therefore an indication that the animals are in condition of reduced well-being."

3.5. Feeding

When domestic pigs are allowed to live in a wooded environment, they continue to devote 75% of their active time to grazing and feeding behaviours, even if fed at will. This means that all pigs are highly motivated to explore their surroundings and graze for food. Living in a familiar box with a nutritionally balanced diet does not eliminate this motivation.

3.6. Resting and Toilet Spaces

Rest area and cleaning area must be distinguished with clear routes to reach the various areas. Pig avoids dirtying the rest area with faeces and urine: it usually chooses an area from 5 to 15 m away from the rest area.

3.7. Giving Birth and Nursing and Nesting

The sow must be free to move, just before farrowing she must have material (plants such as straw or even fabrics) available to build its nest clean and sufficiently large area to give birth, as would happen in nature. https://www.youtube.com/watch?v=gnlhx75UMfc.

4. Goat Ethology

4.1. Definition and Origin

Goats are mammals herbivorous with rumen. It is accepted that the domestic goat (Capra hircus) was first domesticated from the wild bezoar goat (Capra aegagrus) someplace in the Fertile Crescent of the Near East about 10,000-11,000 years ago.

4.2. Physiological Characteristics

When you look lovingly and intently into your goats' eyes, do you wonder why goat eyes are rectangular? The answer lies in specially adapted vision features. But that's not all: Goats also have excellent hearing and a distinctive sense of smell. Their senses differ significantly

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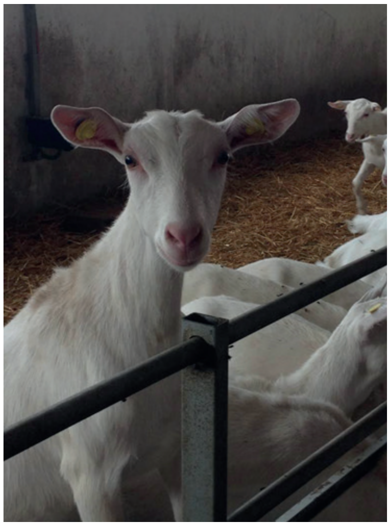
from ours, both in range and sensitivity. This can lead to misunderstandings as they perceive life differently than we do. In any case it is always helpful to think: How do goats see this? Understanding their perspective can help us to evaluate goats sensitively when caring for them. This perspective can help us experience the facility from the residents' perspective while caring for the goats.

Goat eyes and senses were honed over millions of years of evolution before we domesticated them. And goats' eyes are tuned to protect them from predators and cope with the challenges of their natural environment: These natural challenges include, for example, finding food and water in dry, mountainous terrain, climbing, shelter, competition, finding mates, and guarding young goats.

4.2.1. Why Does Goat Has Rectangular Eyes?



First, let's look at the incredible vision of goats. Goat eyes are placed on either side of the head and the pupils are elongated horizontally. As the goats tilt their heads, the pupils rotate to stay horizontal. But why are the goat eyes like that? Because, this configuration allows them to see almost anywhere clearly and sharply for 320-340 degrees (forward and side). There is only a narrow blind spot on the back of the head. This panoramic view allows them to keep an eye out for predators while foraging. This is an important skill at range and in the wild. To aid rapid escape, goats have 63-degree binocular vision and provide depth perception for jumping and climbing over rough terrain.

Slit pupils provide greater light control: narrowing tightly against the glare of the sky while maintaining light capture from the landscape. These eyes, combined with their sensitivity to movement, allow goats to easily spot predators on land. The pupils open wide in low light, and the retina has many light sensors (called rods) and the tapetum lucidum, a bright retinal lining to improve night vision. Goats can thus stay awake while foraging in the early morning and late evening, avoiding the heat of the day.

Goat eyes focus well on distant or moderately distant objects. However, in some cases it can be difficult to distinguish sedentary individuals of goats, especially people who frequently change the color and shape of their clothes. In this case, a gentle gesture and a call to get them to get to know you can help your goats get to know you from afar.

4.2.2. How Does Goat See Colour?

Due to two types of color receptors called cones in their retinas; Goat eyes receive light ranging from violet/blue to green and yellow/orange part of the spectrum. One type is most sensitive to blue light, while the other is sensitive to green. People have an additional type of cone that is sensitive to red light. So goats can distinguish red as a separate color from green and yellow. Most colorblind humans and many mammals, including goats, cannot distinguish between red and green, which looks like yellow.

4.2.3. Why Does Goat Has Hairy Lips?

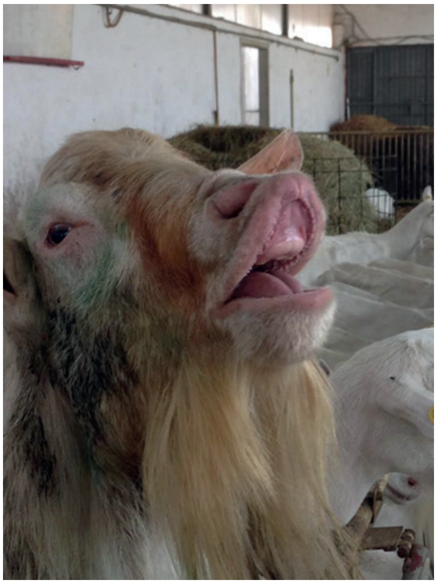
Close-ups with limited focus inherit the excellent senses of smell and touch. Nearby objects are first sniffed by the goats. Nearby generations are sensed using delicate lip whiskers, which then guide their nimble-moving lips to grasp the delicious morsels. The lips are indeed their main grasping tool, through the lips everything is thoroughly explored. For this reason, many people think that goats eat the objects they examine. Normally, this is just a curiosity and non-edible objects are thrown out after a gnaw. The grooves on the inside of the lips (these parts are called rugae) are very prominent in the goat and are used to grasp and manipulate rough vegetation. It is astonishing that such dexterous and sensitive mouths can easily navigate sharp thorns and withstand pins and needles! Lips and muzzles are also used to manipulate objects, doors and locks of doors and barns in a way that terrifies goat keepers.

Lips are limbs that goats use like their hands! As social mammals, goats are very sensitive and enjoy being gently stroked and scratched from other goats or humans until adulthood.

4.2.4. Does Goat Has a Good Sense of Smell?

Goats' excellent sense of smell plays an important role in feeding, protecting from predators and social activities. The moist skin on their noses and inside their nostrils has far more sensors than humans. They recognize and choose food by smell. Moreover, they navigate a sensory world that is hard to think, guided by messages left behind by other animals in the form of scent. Mother goats bond with their offspring by learning their unique scents at first. Immediately after, they communicate through visual and audio recognition.

Pheromones in goats' salivary, urine and scent glands are unique to each goat and provide information about the goat's identity, sex, health, sexual sensitivity and possibly emotions. The scent glands are located behind the horns, under the tail, and between the front toes. Goats sniff each other at the meeting, gaining prior knowledge before challenging for a rank in the



hierarchy. They also like to sniff other animals and people at the entrance. I've found that shy goats help them accept new people if we crouch on the ground and let them sniff us, letting the goats approach in their own time.

Goats rarely need a sniffing update unless a herd has been away for a while or something has changed about the herd. Goats mates are seen sniffing their mouths and horns during fight and play, possibly to check how they are doing. Females sniff each other when one of them is in heat and pay close attention to the development of their mates' anger. Pheromones, hormones, and other animal signature blends are non-volatile, water-soluble chemicals. Therefore, they must be absorbed in the moist tissues of the nose and mouth before being analyzed. They are then pulled into an organ called the vomeronasal organ between the two. This is achieved by drawing a funny expression called flehmen. The smelly truth about goat breeding involves the urine sample.

Male goats use female urine to check their readiness to mate. Females also use flehmen to study animal odors.

4.2.5. Goat Hearing Range and the Meaning of Bleats

Goats have a wider range of hearing and much higher pitch than humans (goats: 70 Hz - 40 KHz; humans: 31 Hz - 17 KHz). Goats are often alert to sounds we cannot hear. They can be bothered by sounds that are imperceptible to most of us, such as the high-frequency squeaking of electrical machines and metal appliances. Sudden, loud or high-pitched sounds, such as children's screams and people's laughter, can trigger an alarm condition. This is plausible, as goats emit loud, high-pitched, trembling bleats when in trouble. Children's bleats are high-pitched to get their mother's immediate attention. Aggressive bleats are hard and deep.

Finding sound in goats is not as accurate as in humans, so they turn their ears to determine the direction of each sound. A cautious goat listening for danger can often be seen with its ears pointing in different directions.

Voice is also used in communication between pack members. There are gentle bleats that are used only to maintain contact: quiet, steady, low-pitched and usually given with the mouth closed. This is how mothers murmur to their children. You can imitate these soft sounds to keep your goats calm during transport.

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4.3. Understanding Goat Senses for Easier Handling

Sensory information, such as when the visible object is blurred, is combined to give goats various ways of perceiving danger, food, and mates in varying conditions. Sight memory is also stored by the senses and other elements are triggered. Goats can associate a place, shape, color or clothing with an unpleasant event and remember it for a while. Likewise, goats associate sights, sounds, and smells; this means we benefit from goat training to make management procedures run more smoothly.

Goats may not understand many of the things we do and may interpret some of our actions in ways that are very different from ours. If you catch goats for treatment, we trigger an instinctive fear that their movement will be restricted. When we step outside of our normal routine, a degree of insecurity and fear of the unknown arises.

It's better if you keep a calm demeanor, use slow and gentle movements when handling goats, and talk to them in soft tones to avoid triggering sensitive predator warning systems to calm them down. We kindly introduce them to new areas and equipment. We don't rush, we let them smell, listen and explore. Using our knowledge of goat perception and how goats think and feel, we can understand their responses to their environment and make transportation easier and more efficient.

5. Sheep Ethology

5.1. Definition and Origin

Sheep are herbivorous mammals with rumen. When we look at the history of domestic sheep, we see that it goes back to between 11,000 and 9,000 BC and the domestication of wild sheep in ancient Mesopotamia. The sheep is one of the first animals domesticated by humans. These sheep were raised primarily for meat, milk and leather.

5.2. The Sheep Flock and Its Social Behaviour

Sheep are typical social "herd animals". Herds graze together as a defense against predators. They flee by moving a short distance to form a pack, and then turn to face the predator. As the sheep approach the hunter, they disperse and regroup.

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In sheep, the social hierarchy is not as clear as in other species. Normally you'll see very few encounters between ewes that don't have young lambs to fight. They establish a social order in sheep by nodding, poking, poking with horns, pushing shoulders, blocking each other, and jumping on them. This is most clearly seen in horned rams (American wild mountain sheep), then retreating and attacking in a head-on encounter with a massive explosion. Horned and horned rams should not be confused because a horned ram breaks the other's neck.

Behaviors that involve lowering the head and neck and walking away with a nod are considered submissive. In wild sheep, a dominant ram leads a small flock, followed by females, cubs, and lambs. He establishes it as a harem of a dozen sheep. Rams can form specially arranged harems in farm herds on large hilly meadows where they can easily be separated from the main herd. To prevent this, regular meeting is needed.

In wild sheep, a lamb stays with its mother until the next lamb is born. Both sexes will remain in family groups until the adolescent males move elsewhere. In farm herds, you won't see much evidence of social order because many of them have restricted movement.

Merinos, who do not have a shadow in groups of rams, especially in hot climates, stand in a tight herd and create shade for each other. Merino is the type that shows this tight packing pattern when judging by the breed, and once in a tight circular mob you have to find a leader to jump out of place and act as a leader to get some movement.

This leading sheep does not hold a high social rank. the first sheep to think they can escape. The pressure of barking dogs only tightens the pack. In such a situation, if you are in the middle of the crowd, you may feel the physical pressure that can cause you to suffocate. Merinos need space to move around and hate difficulties. They have different behavior from other farm breeds.

5.3. Feeding

Sheep are ruminant animals and they start to graze on the pasture from about a week old. They are animals that start ruminating productively at the age of about one month. Sheep can graze closer than cattle because they have a split upper lip. They graze for about 8-9 hours a day. This can take up to 13 hours when they have trouble finding food. Grazing bouts (when forage is plentiful) are about 20–90 minutes and can be up to 9 in 24 hours. After a grazing cycle, there are 45-90 minute periods of rumination and rest.

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In the open field, sheep have private areas and remain attached to these areas. This is seen in the 'hefting' system of hedgeless mountain grazing in the UK. The biggest concern in the UK Foot and Mouth disaster was how to replace these sheep as they had to relearn after slaughter.

Mixed grazing of cattle and sheep is ideal for maintaining a good close pasture. And sheep are expected to adapt to this without any behavioral problems. The condition of a sheep's teeth is critical and can have a major impact on behavior.

Sheep learn from their mothers which feeds they should prefer to eat. South Island sheep eat grain and hay as they learned from their mothers in the spring. North Island sheep generally do not eat grain or hay as it is never offered to them, except for special factors such as severe feed shortages such as drought. Sheep usually take 2-3 weeks to learn as mature animals, and some may never accept additional feed and starve. Sheep also learn to forage differently from other adults or their peers.

Sheep have the ability to store excess energy. Sheep store it as fat in the body cavity (eg kidney fat and around the intestines) and under the skin. They use it for lamb growth and milk production during late pregnancy and lactation.

Approximately 3-4 weeks before mating, the sheep are given extra feed to facilitate the ejection of excess eggs from the ovary. And thanks to this method, more lambs are produced. This is called "flushing".

Sheep kept indoors show stress by eating the wood of their corrals, and in the next corral they also eat their own wool or the wool of the sheep. This wool-eating is seen as sheep buried in deep snow for up to three weeks.

Adult sheep need about 4 liters of water per day. Lambs need about 1 liter of water a day. But sheep are good at adapting to severe drought conditions and can get enough moisture from grass to survive. Australian country Merino best displays this important behavioral trait.

5.4. Physiological Characteristics Sight, Smell etc.

5.4.1. Sight

Sheep generally have very good eyesight. The position of the eye provides wide peripheral vision. They can see with each eye at an angle of approximately 145 degrees. Binocular vision is much narrower. It is 40° wide. They do not immediately see 2-3 cm in front of their nose. After finding a threat in their peripheral vision, they begin to examine it with binocular vision.

They have a blind spot of around 70° behind them, which is wider than the cow and useful when catching sheep. The tracks left by the sheep as they walk are never in a straight line, because the sheep constantly turn their backs and watch. Sheep have enough vision to distinguish colors, but it is not as well developed as in humans. They often react fearfully to new colors they are not used to, such as a yellow raincoat. Sheep can remember their herd mates long after they have been separated from a flock.

5.4.2. Smell

Sheep have a good sense of smell and will not eat moldy or musty-smelling feed. Smell is an important factor in helping rams find sheep in heat. Fragrance is also vital in the identification of lamb by the mother. It is linked to vision recognition. Sheep are very sensitive to predator odors. Feed intake was measured with different predatory odors on it. See below:

- ✓ Normal Coyote odor intake 8.38kg/head, with odor 0.45
- ✓ Normal Fox odor intake 8.69kg/head with odor 0.37
- ✓ Normal Puma odor intake 9.32kg/head with odor 0.47

5.4.3. Hearing

Sheep have a developed sense of hearing and can turn their ears in the direction of the sound.

5.4.4. Touch and Taste

The sense of taste and touch are not of great importance for sheep, even the least important in terms of smell and taste. Their taste buds are pretty much the same as ours: a way to tell if food is good to eat. When you see a sheep grazing in a meadow, you may notice that they will first turn to certain plants that are very appealing to them because they taste good.

Touch is not a keen sense for sheep. Their wool or hair doesn't give them many opportunities to be touched. Lambs and sheep seek opportunities for body contact as an important part of bonding. And lambs often hug their mother at night.

The most common way a sheep is touched is by their noses. Watch your sheep when they see something new. They stretch their necks to smell the object. And then, if everything seems fine, they touch it with the nose.

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UNIT 5

BREEDING

INTRODUCTION

With thousands of different livestock breeds across the globe, it is no wonder farmers are spoilt for choice when it comes to breeding. Selecting the right breed is critical when it comes to a successful farming business and even more important in organic systems due to the constraints of the organic regulations. Ideally, breeds should be chosen that are adapted to the local environment, disease resistant/resilient and able to thrive on the forage available.

Native, traditional and local breeds are usually the breed of choice in organic systems as they intrinsically have these traits.

The principles of methodical selective breeding began in the late 1790s and years of using this method gives rise to the breeds we use today. Advances in phenotypic and genotypic technologies have increased genetic gain within breeding programmes, leading to more productive and efficient farming.

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1. Breeding Overview

In organic systems sourcing and selecting livestock breeds is critical to ensuring a productive farming enterprise. Breeds selected must be suited to the local environment and ideally be resistant and resilient to diseases. This will ensure that organic standards can be achieved throughout production. Those which do not have these innate abilities, are not generally suited to organic systems as will often require too many external inputs making them unsuitable for organic farming.

1.1. Sourcing Livestock

Ideally in organic systems (and those in conversion) all animals are bred on the holding to maintain organic status. However, for breeding purposes and to avoid any inbreeding, this is not always possible, and animals from other farms may be brought in, preferably from other organic holdings. If this is not possible, and with specific permission, animals that are in conversion or those that are non-organic can be used. Discussions with an organic certification officer must take place before the non-organic animals are purchased and brought onto a holding. Records must be kept (see Chapter Food Safety, section 3.1. Record Keeping for more details).

When selecting livestock for organic systems, native breeds or strains are generally favoured. A list of criteria from organic standards guidelines may be useful for selecting livestock to bring in from another holding.

Where possible, animals should:

- ✓ Be suitable to thrive in the location of the holding e.g. animals adapted for harsh, mountainous conditions in holdings located high above sea level.
- ✓ Have resistance to disease and show appropriate vitality. Some breeds are predisposed to health issues such as porcine stress syndrome, difficult births requiring caesarean sections, abortion, sudden death syndrome etc. These breeds should be avoided in organic systems.
- ✓ Not need any mutilation. This will be possible where indigenous breeds and/or those adapted to local climate are selected.

Organic standards require that livestock which are obtained from non-organic sources, may need special measures (e.g. screening tests) or specific quarantine periods decided by the local authorities. Therefore, farmers should check with their local organic certification body before bringing animals onto their holding, as this could compromise their organic status.

1.2. Establishing a Flock or Herd

When establishing a new herd or flock for a holding, “in conversion” animals may be sourced from any holding, regardless of organic status. Once the land becomes organic, these animals must be reared to organic standards, and any further animals brought in must comply with the details listed in section 1.1. Alternatively, the land and the animals may be converted to organic status simultaneously.

When bringing animals onto a holding for rearing purposes, there are additional regulations which must be adhered to in order to achieve and maintain organic status:

- ✓ Calves must be less than six months old.
- ✓ Lambs must be less than 60 days old.
- ✓ Piglets must weigh less than 35 kg.

All animals in this scenario must be brought in at weaning and reared on the holding to achieve organic status.

1.3. Breeding in Organic Systems

Like most elements of organic systems, there are some constraints on what breeding techniques can and cannot be used to meet organic compliance. Ideally, natural mating should be used for breeding. In some scenarios, artificial insemination may be better suited for the farm, allowing specific bloodlines and genetics to be introduced to the stock.

Artificial insemination is permitted under organic standards. This may be appropriate to ensure that the high health status of the herd/flock is maintained and to reduce the risk of introducing disease into breeding stock. It also allows greater control over the number of pregnancies, farmers can plan when young stock are born, specific genetic traits can be selected and is very useful for breeding in endangered or rare breeds.

Where natural mating is used, an on-farm health programme should be in place to control transmissible diseases and reduce the associated risks. Other breeding techniques such as embryo transfer, cloning or oestrus synchronisation are not permitted in organic systems

Reproduction is not allowed to be induced or impeded through hormones or similar substances. These are only permitted under advice from a veterinary surgeon and on a case-by-case basis.

When selecting breed/s for establishing a livestock enterprise or when new breeds are being introduced, careful consideration of suitable breeds should be undertaken. Stock will be kept under organic principles including being kept extensively outdoors, and therefore breeds used should be suited for survival in the local climatic environment. They should ideally be resistant to common diseases, or those that occur locally. They should also be breeds which will allow high animal health and welfare standards to be achieved, again with limited intervention. In addition, breed characteristics should contribute to the prevention of suffering and/or the need for mutilations, which must be avoided in organic systems. Breeds should also be selected with a degree of genetic diversity, along with longevity and vitality.

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This is also true for organic plant production, where organic plants are grown for sale or to use as feed for organic livestock. Breed varieties must be selected that are suitable for organic production. Therefore, plant selection needs to focus on enhancement of genetic diversity, reliance on natural reproductive ability and agronomic performance, as well as consideration of disease resistance and adaptation to diverse local soil and climate conditions.

1.3.1. Breed Diversity and Heritage/Native Breeds in Organic Systems

Native and traditional breeds are vitally important in organic systems as they utilise characterises and traits which occur naturally to work with organic farming principles. In organic systems, breed choice is key to a productive enterprise. Breeds are chosen which are adapted to the local climate, environment and grass forage available. Usually, native breeds are well adapted to their local conditions and are well suited for extensive grazing and forage conversion when compared with other non-native breeds. As a result, the use of native and traditional breeds in organic systems tend to go hand in hand. In addition, traditional breeds can contribute to the extensification, diversification and environmental conservation objectives of organic farming. However, the identification of the breeds that are best suited for organic production are still under debate.

1.3.2. Breed and Meat Marketing

One of the critical decisions in converting a farm to organic production is how produce will be marketed. In some EU markets (and the UK) breed and heritage are important parts of the story which consumers want to know. A YouGov survey carried out for the UK National Sheep Association into consumer attitudes to buying meat based on native breed, found that a good majority of respondents (35%) said that if they knew a piece of sheep meat was from a named native breed, they would be more likely to buy it. 2% said they would be less likely, and 43% said it would make no difference to their decision to buy.

Marketing organic meat is primarily about telling the story behind the meat and differentiating it from the conventional mass-market product. Choosing a native breed makes the telling of that story easier and generally more attractive to many consumers. In many cases it can demand a premium price.

1.4. Replacing Breeding Stock

Organic systems function better as a closed flock/herd, where replacements are bred on-farm to reduce the risk of introducing disease. However, replacement stock may need to be brought in to prevent inbreeding and to introduce new breed characteristics, which have the potential to add genetic benefit the flock/herd. When replacing breeding stock from off-farm, ideally animals should be sourced from organic holdings. Where this is not possible,

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non-organic animals are allowed to be brought onto a holding for replacement purposes. Any breeding stock brought onto a holding must be kept in accordance with the organic standards. When bringing in non-organic females the following proportions of the existing herd/flock can be brought in from outside the farm:

- ✓ Only up to 10% of the existing adult numbers for cows or equines per year. This includes species of buffalo and bison.
- ✓ Only up to 20% of the existing adult numbers for pigs, sheep and goats per year.
- ✓ Only 1 animal if there are fewer than 5 pigs/sheep/goats or less than 10 cattle/equine.

When farmers are significantly increasing their herd/flock size they are allowed to bring in non-organic animals up to 40% of the existing adult herd/flock size. This is also true if they are introducing a change in breed, developing a new livestock enterprise or the herd/flock is a rare breed. Prior permission (in writing) must be obtained before this occurs to maintain organic status.

There are some additional exceptions to these limitations for bringing in non-organic breeding stock. For example, under cases of high mortality caused by health or disastrous conditions farmers may renew their herd/flock with non-organic animals. However, this must be authorised by your certifying organic body. See Chapter Farm Management, section 1.1.4. Biosecurity for details on preserving health of your existing stock.

2. Fundamental Principles of Genetic Selection and Genetic Basis of Inheritance

Early animal breeding, particularly in cattle and sheep, took a systematic approach in 1792, when British farmer **Robert Bakewell**[2] began promoting accurate pedigree records, highlighting the importance of stabilising valuable traits and progeny testing to assess the genetic potential of young sires. Bakewell's ideas were adopted by many farmers with striking results. As a result of Bakewell's ideas, progress in animal breeding focused on selection decisions made on information gathered from related individuals. This was the beginning of selective breeding.

Selective breeding can be defined as selective favouring of an animal for breeding in a strategy to create a population best suited for a specific breeding objective. These can occur naturally within populations through animals living, roaming and mixing with isolated populations, and then moving on again. This can also occur through human intervention.

2 Robert Bakewell's photo was taken https://www.britannica.com/biography/Robert-Bakewell.

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Domestication of animals is one of the main examples of selective breeding. Domestication can be defined as: "An animal that has been selectively bred in captivity and has therefore been altered from its wild and ancestral nature for use by humans who control the animals' breeding and food supply." The livestock we see dominating farming today were the first animals to be domesticated.

There are three main strategies to improve breeds. These are selection between breeds, selection within breeds and crossbreeding. All strategies can be as important and when used properly, fulfil useful functions. Selection can be used to add valuable traits to breeding stock, such as increased fertility, resistance and resilience to disease, increased yields (milk) and/or better carcass conformation (meat). This is extremely useful in organic farming as it can help to achieve sustainable production systems, reducing and/or removing the need for chemical intervention and additives which helps organic farmers maintain compliance with organic standards.

2.1. Selection within Breeds

Pure breeding (within an existing group of animals) allows for simple breeding decisions, makes marketing a product easy (as there is little variation) and can be beneficial where resources are limited (as it doesn't always require splitting the flock or herd). Where segregated fields are limited, or time is limited, pure breeding can be an easy method for achieving an expected result. One of the quickest and easiest methods for making breed selection on farm is choosing the best sires to breed any future sires on farm, and also choosing the best dams to breed future breeding stock. This should produce the best future genetics to continue using in a pure breeding programme.

However, there are some disadvantages to pure breeding, such as the lack of opportunity for hybrid vigour (see section 2.3. Crossbreeding for more details), capitalisation on breed differences cannot be used and rate of change is slow as there is only one population for selection. In addition, if the trait or gene of interest isn't present in that breed population, there is no scope to breed it into a herd/flock, making traits finite. Care also needs to be taken to avoid negative effects of inbreeding. This reduces the genetic diversity within the gene pool and can result in recessive or unwanted traits becoming prominent due to over-selection.

2.2. Selection between Breeds

Selection between breeds is using different breeds to introduce different characteristics into breeding stock. Like selection within a breed, breeds with the best characteristics are selected and mated to produce offspring with improved traits. Unlike pure breeding, picking specific breeds allows the introduction of new characteristics into breeding stock. This allows the accumulation of favourable traits from generation to generation. With organic systems, care needs to be taken when introducing new breeds as the breed needs to be suitable for organic systems (as described in section 1.3. Breeding in Organic Systems).

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However, selection can be difficult as it may be difficult to tell what characteristics will be inherited by using visual inspection alone. This is particularly important when selecting terminal sires. Selecting the biggest and best sire to produce replacements, doesn't always result in the biggest and best offspring. There are also additional factors such as prolificacy of daughters, life expectancy and resistance to disease of their offspring that cannot be positively selected based on phenotypic analysis alone. This is where estimated breeding values (EBVs) are useful for aiding decisions in selecting terminal sires. EBVs are traits of interest that occur across different breeds (see section 2.6.1. Phenotypic-Breeding values for more details).

2.3. Crossbreeding

Crossbreeding allows the farmer or food producer to choose breeds that are equivalent to, or ideally add value to livestock. This method uses crossbreeding to introduce dominant traits within each generation of breeding. Crossbreeding also allows hybrid vigour to be introduced into progeny, which cannot be achieved with pure breeding. Hybrid vigour is the extra performance of a crossbred animal that goes over and above the average performance of their parents. Using better DNA techniques has allowed improved management of crossbreeding to avoid unwanted traits being observed (see section 2.6. Breeding tools available).

Introregression is the incorporation of genes of one species into the gene pool of another using repeated backcrossing of an interspecific hybrid with its parent species. However, there are limitations in that it reduces genetic diversity, there may be unpredictable pleiotropic effects, there is poor interspecific cross-ability and in some cases, Genetic Modification (GM) technologies are needed where species are not sexually compatible and won't produce viable offspring. GM is banned in organic systems, therefore could not be used (see Chapter Food Safety, section 1.2.1. GMO).

2.4. Genetic Inheritance

To use selective breeding, the farmer or food producer needs to understand the farm's breeding objective. What do they want to achieve and therefore what traits in the stock will help them achieve this? Examples of the different traits which are seen as beneficial for different stock categories can be found in table 1. Once it is decided which traits need to be used, a process of benchmarking within the flock needs to be undertaken. Once the flock/herd has been benchmarked, it can be compared against industry values to gauge performance.

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Table 1. Different traits which would be selected for dependant on breeding objective for the end animal

Category	Traits
Young stock	Survival Growth rate Fat class Carcass conformation
Maternal (breeding)	Fertility Prolificacy Lambing/Calving/Kidding/Farrowing ease Disease resistance Maternal ability Mature size Longevity Ease of management – temperament
Terminal	Muscle depth Fat depth (lower = leaner) Growth rate

Characteristics or traits can be genetically inherited from parents. **Gregor Johann Mendel**[3] is considered the father of modern genetics with his genetic discoveries in pea plants in the 1860s, where he successfully demonstrated the 3 laws of heritability:

- ✓ The Law of Segregation: Inherited traits are defined by a gene pair. During reproduction, parental genes are randomly separated into sex cells containing one gene of the pair. As a result, offspring inherit one gene allele from each parent when the sex cells fertilise and become one.
- ✓ The Law of Independent Assortment: Genes for different traits are sorted separately from each other, therefore inheriting one trait is not necessarily dependant on inheriting the other trait. This is affected differently by linkage.
- ✓ The Law of Dominance: Where an organism has alternate forms of the same gene, the dominant gene will be expressed.

3 **Gregor Johann Mendel's photo was taken https://tr.wikipedia.org/wiki/Gregor_Mendel.**

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These laws led to the discovery of phenotypes (what characteristics are visually displayed) and later advances in genetics allowed genotypes to be characterised. Genotypes are the genetic makeup that is inherited by offspring from their parents. Unlike genotypes, phenotypes are not inherited. Phenotypes are influenced by genotype, but genotypes do not necessarily equate to phenotypes displayed. The average performance of a group of animals is determined by their genes and the environment they are kept in. Therefore, selection is also affected by the environment. Animals kept in a positive, healthy environments may mask animals of poor genetics. The opposite is true for animals kept in poor conditions may have superior genetics, but they are masked by poor husbandry. Therefore, the environment is very influential when it comes to selective breeding. Organic standards ensure high animal welfare, high health and natural diets, so therefore selection may be more difficult as inferior genetics may be hidden.

Mutations that occur either in hereditary material or in cells that produce the next generation will affect the organism's offspring. Mutations can be harmful, beneficial, or neutral to the host but are key for future diversity and evolution. Interplay between mutations and environmental pressures also generate diversity. In general, the mutation rate is very low. Despite DNA replication being an error-prone process, cells have natural mechanisms to restrict the level of mutations. Mutagens are chemicals which increase the risk of DNA damage, increasing the likelihood of mutations occurring.

2.5. Limitations on Selection

However, there are limitations on selection. Factors such as sex-linked and age-limited traits can prevent problems affecting the heritability within livestock. There are also genetic antagonisms between health traits and production traits which need to be considered. In organic systems, where chemical interventions are prohibited, production needs to be efficient and economically viable. In some instances, focusing on other traits (such as health, or carcass conformation) can negatively affect basic production. This can occur in dairy systems, where crossbreeding is used to add value to bull calves (increasing carcass conformation) but reduces milk yields in maiden heifer calves as a side effect. Therefore, breeding programmes need to be planned, monitored, and reviewed to ensure other traits are not favoured over production. This can also occur when selecting for resistance or resilience to disease such as parasite resistance. Being resistant to some diseases through selective breeding can result in animals being more susceptible to other diseases. This demonstrates that in all farming systems, selective breeding of any kind needs to be planned and reviewed regularly. Selection pressure and the speed at which traits can be successfully integrated into a farm's livestock is affected by generation interval (speed at which change can be adopted) and is also affected by the number of offspring per birth.

Table 2. summarises the challenges for sheep and cattle in comparison to pigs and chickens due to the variations in length of generation interval and size of litters.

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Table 2. Selective pressures for different species

Species	Generation interval	Offspring per year
Beef cattle	2.5 years	1
Sheep	1 year	2
Pig	1 year	25
Chicken	6 months	250

For cattle and sheep, the turnaround time between litters is slow. This makes selection difficult both within and between breeds as building accurate, robust data sets take a long time.

2.6. Breeding Tools Available

Advances in biological sciences have changed breeding techniques enormously with improved DNA tools allowing certain diseases to be detected and eliminated during breeding. Tools are either based on phenotype (traits that can be visually identified) and genotype (genetic based of which some can be tested for). The majority of selective breeding programmes use breeding selection based on superior phenotypes. With the additional of improved statistical methods that focus on maximising selective genetic gain, the simplistic approach has been successful within agriculture, especially for increasing production. Molecular genetic information is increasing and has been adopted by industry (mainly in dairy cattle). The extent of its use has not lived up to expectations and seems to be adopted on an ad hoc basis, rather than as a breeding programme.

2.6.1. Phenotypic - Breeding Values

Estimated breeding values (EBVs) are traits of interest that occur across different breeds. An EBV shows the genetic gains of that specific animal and therefore its potential as a sire or dam for specific traits. For individual traits, animals are assigned EBV values that predict the differences in the performance of the animals' offspring (QMS, unknown). In general, larger values are equal to better EBVs but in some instances, smaller values are selected for (e.g. faecal egg counts). This is not based on genetic identification, and therefore the true breeding value of the animal cannot be verified. However, through individual performance recording and performance recording of an animal's relatives, trait information and trait heritability allow an EBV to be given. EBVs are produced from performance recording, information regarding the animals' pedigree (if any) along with the animal's age and environment, which is inputted into an analytical model known as a best linear unbiased prediction (BLUP). This method allows separation of genetic and environmental data for how the animal performs and looks. Genomic EBV (GEBV) do exist and tend to be equal to standard EBVs or more accurate as they use parent averaging information.

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Methods for measuring breeding values includes progeny testing (to see what it actually does), performance testing (what it should do) and pedigree (what it should be).

Progeny testing take a long time to gain results. Traits can't be directly measured, and it can be an expensive process. However, it does give a direct measure of breeding value, showing exactly how superior the gene is.

Performance testing measures an individual's performance relative to the performance of its contemporaries. It assumes that animals performing in the same environment should perform differently due to their genetic make-up. As a result, those with superior genes should perform better. Therefore, this method predicts breeding value. This is much quicker than progeny testing and allows individuals to be tested directly. But there are limitations. Care needs to be taken to avoid preferential treatment of those with superior genes as this would falsify any superiority observed. If the breeding value is of low heritability, limited results will be observed. Unlike progeny testing, it does not give you a measure of exactly how superior the gene is.

Pedigree evaluation links ancestors and relatives. It uses the performance data of these groups. Progeny testing is a form of pedigree evaluation. Without performance recording and pedigree data, EBVs would not exist. Years of performance recording and pedigree data is used to create EBVs, which produce index value for farmers to work from when selecting breeding stock.

EVBs rely on the ability to record phenotypes accurately so decisions on future selective breeding can be made. There are also limitations in that some traits are not observed until later in life (longevity) therefore data sets can be laborious to produce.

Once a decision is made on what traits need to be achieved, a process of benchmarking within the flock/herd needs to be undertaken. Once a flock/herd has been benchmarked, it can be compared against industry values to gauge performance. As explained above, this can take years, depending on the trait being monitored.

Further factors that can affect progress when using EBVs include accurate recording, computer power, breeding structures, international efforts, molecular genetics, and reproductive technology (if any) that is used. These phenotypic limitations also impact on genetic progress that can be made.

2.6.2. Genotypic - Genetic Tools

The era of molecular genetics began in the 1970s providing new opportunities to enhance and progress within livestock breeding programmes. Initially single genetic defects were able to be detected, allowing some negative traits to be avoided. But genetic testing was costly, time consuming and underused by most farmers. Further advancements allowed improved technology leading to genotyping of animals and a greater understanding of genomics.

Genomics enables the study and analysis of an animals' genes and DNA. Genotyping is a method of genomics which uses laboratory testing to produce an exact picture of an individual animal's DNA. This allows the determination of the risks of disease the animal is predisposed to as well as allowing an assessment of the productivity and profitability of this animal. With improvements in genetic technology, information is now available on the organisation and functioning of the genome and how they affect a range of traits.

The majority of traits are under the control of several genetic loci, referred to as quantitative trait loci (QTL). QTL contribute to variation in the trait but are not as effective for selective breeding as markers for functional mutations within these QTL. Genetic markers to identify QTL and their use in marker-assisted selection has had limited use in practical breeding programmes.

Genomic selection is an expensive tool to use but does allow the farmer to identify animals within their breeding stock with the greatest genetic potential. It then allows them to utilise this knowledge to maximise desirable traits during selective breeding. GM or gene manipulation is prohibited under the organic standards, but analysis of an animals DNA for future breeding strategies that don't use GM are acceptable.

3. Priority Genetics for Production (and other considerations)

Genes can be defined as units of heritability which are transferred from parents to their offspring and result in similar characteristics being observed in the offspring. Different characteristics will have ranging heritability and heritability does not directly affect selection. Genetic correlations are where two different traits can be measured on the same animal and are linked. If genetic correlation exists between these traits, selection on one trait can give a correlated response in the other. For example, litter size in sheep is correlated with yearling weight. Genetic selection for milk yields will increase yield of fat and protein, as well as reduce fat and protein percentages. With regards to organic systems, there are specific traits which should be selected for to produce an efficient system under organic regulations. A summary of these can be found in table 3 segregated by species.

Table 3. Summary of livestock traits related highly important by organic farmers

Sheep	Beef	Dairy
Ease of lambing	Ease of calving	Ease of calving
Scab	Forage conversion	Forage conversion
Foot rot and worm resistance	Lameness and mastitis	Lameness and mastitis
Suitability for conservation grazing	Suitability for conservation grazing	Marketability of milk and calves
	Marketability of meat	Good feet and legs
	Finishing before 24-30 months	Longevity
		Udder
		Temperament

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It is understandable that there will be different traits selected for between different livestock species as the objectives between farming systems differ. Organic production systems are based on the use of local feed, natural processes, survival in local environments and the maintenance of biodiversity. Reducing difficulties at lambing or calving seems to be very popular in organic systems as well as reducing the incidence of disease **(table 3)**.

The following sections will discuss individual livestock species, focusing on useful characteristics and traits within each system with a focus on organics.

3.1. Dairy

Selection objectives within the dairy sectors are dependent on the market requirements as well as milk contract and production systems. These differ between farms, meaning selection objectives will differ too. However, the majority of dairy systems will focus on production-based selection such as:

- ✓ Yield: for milk, fat, protein and persistency.
- ✓ Milk composition: fat % and protein %.
- ✓ Animal health: locomotion, body condition score, longevity.
- ✓ Reproduction traits: calving ease, fertility.
- ✓ Disease resistance: Mastitis.

In organic systems, the preferred traits differ as the overall breeding objective is not always to simply increase production (e.g. increased milk yield). The principles of organic favour outdoor, extensive living with limited interference. Therefore in organic systems, the main aim isn't necessarily to increase yields. The organic breeding focuses are usually aimed at introducing health and resistance to disease, high forage conversion and adaptations to outdoor extensive living. A survey by Scottish Agricultural College investigated the ranking of various traits within organic dairy farmers. To account for country variations a study surveying organic dairy producers in the Netherlands and in Switzerland is included in **table 4**.

Table 4. Overview of the most important traits for organic dairy breeding in Scotland, Netherlands and Switzerland

Rank	FIBL (Switzerland)	SAC (Scotland)	LBI (Netherlands)
1	Fertility	General disease resistance	Fertility
2	Cell count	Mastitis resistance	Udder health
3	Longevity	Longevity	Long productive life
4	Milk from forage	Somatic cell count (sub-clinical mastitis resistance)	Good milk yield/lactation
5	Protein and fat content	Female fertility	Protein and fat content
6	Udder health	Forage intake capacity	Conformation udder
7		Feet and leg strength	Quality of legs
8		Susceptibility to lameness	
9		Resistance to parasite infestation	
10		Robustness/hardiness	

The trends across organic dairy farmers seem to be more focused on fertility and health related traits, rather than production. This makes sense as organic regulations ban the use of certain chemical products (veterinary products, hormones) that can be used in conventional systems. Therefore, organic dairy farmers must use selective breeding to breed-in valuable traits and characteristics to avoid health and fertility problems. In addition, based on the findings outlined in table 4, future breeding stock in organic systems would need to be assessed on:

- ✓ **Locomotion**

  Gait scores can be used to help farmers to select against lameness. These scores can then be used to reduce susceptibility to foot problems in the herd and future replacements. This helps in conforming to organic standards as it breeds-in resistance and resilience, removing the need for veterinary intervention.

- ✓ **Calving ease**

  Monitoring calving ease can be used to help farmers select against calving difficulties and predict future susceptibility to problems during calving. “Direct calving ease” predicts the ease of calving offspring from a bull. “Maternal calving ease” predicts ease with which daughters of that bull will give birth. These values can be used to actively select future replacement cows, to reduce the risk of calving problems by selecting those with good calving ease scores for future breeding programmes.

- ✓ **Fertility index**

  This measures the calving interval, non-return rate, body condition score, milk yield around time of artificial insemination, days calving-first insemination, number of inseminations to get in calf. These factors give the farmer an indication of how fertile the cow (and future offspring) will be. As shown in table 4, fertility is very important in organic systems, therefore animals with high fertility need to be selected for.

- ✓ **Profitable lifetime index (£PLI)**

  This can be used to predict the economic benefits over the lifetime of the cow. As organic systems aren’t necessarily as productive in term of direct milk yield in comparison to conventional systems, this indicator allows some element of the economic value of the organic animals to be factored in during selective breeding. By using this instead of direct production, ensures more important traits aren’t sacrificed simply to increase production.

- ✓ **Low somatic cell counts**

  This is linked to the risk of mastitis. This is crucial in dairy systems as mastitis reduces milk yields as well as causing the animal pain and suffering. These need to be avoided in organic systems as treatment would lead to a derogation.

- ✓ **Temperament in the parlour**

  Selection for animals being calm and docile during handling, removing any animals showing signs of aggression or excessive fear during handling or in the milking parlour is beneficial in dairy systems. This would be classified as a management trait. A mother's defensive aggression towards any human or animal that tries to interfere with her offspring is a trait that has evolutionary advantages for wild animals. It could be argued that in other organic systems where animals aren't handled daily that this trait may prove advantageous for organics. For example, protecting their young against predators which they are at a higher risk from in extensive grazing. However, in dairy systems, reduced aggression would be beneficial for improving animal health and welfare of the milkers.

✓ Ease of milking is another management trait.

To manage some of these traits and characteristics, selection between breeds and crossbreeding need to be considered in organic systems. There is also the need to manage health-related problems in homebred replacements, adding further selection criteria to the breeds of interest.

Holstein Friesian breed is the most popular dairy breed for conventional systems due to years of breeding making this the most productive breed. However, this is not necessarily true for organic systems, which can be very heterogeneous, with no single bred being suitable for all organic systems. A summary of the pros and cons of the Holstein Friesian can be found in table 5. Crossbreds of this within organic systems, may prove advantageous to maintain a viable milk yield but introduce other valuable traits suited to organics.

Table 5. A summary of the pros and cons of the Holstein-Friesian breed and crossbreeds with this

	Pros	Cons
Pure-bred cattle other than Holstein-Friesian	• Robust and genetically better adapted to local conditions (lower feed quality, parasites, diseases, climatic stress, etc.) • Greater longevity and fertility • Some breeds have better fat and protein milk contents • Higher value of newborn males and culled cows	• Lower milk production • Lack of herd books
Cross-breeding Holstein-Friesian with rustic breeds	• Improved fertility, longevity and udder health • High capacity for pasture intake • Usually intermediate production between Holstein-Friesian and other pure breeds • Tendency to produce higher fat and protein contents than Holstein-Friesian • Higher value of newborn males and culled cows	• Dilemma about what to do after the first cross to obtain reposition • No direct payments to farmers within the framework of the common agricultural policy* • Lower valuation in agrarian insurance than pure breeds
Rustic Holstein-Friesian	• Reasonable reproductive and productive performance under pasture conditions • Lower maintenance requirements than North American Holstein-Friesian • Better milk production than other pure breeds	• Strains adapted to organic systems should be selected

As explained earlier in section 2. "Fundamental Principles of Genetic Selection and Genetic Basis of Inheritance", using selection methods such as crossbreeding can introduce beneficial traits. A key example of this can be observed in tables 6-9. These demonstrate the value of crossbreeding when selecting against calving problems. Here the effect of sire breed on calving from pure Holstein heifers is shown in table 6; the effect of sire breed on calving from pure Holstein dams in **table 7**; the dam breed effect at first calving in table 8 and the breed effect on survival and fertility in **table 9**.

Table 6. Effect of sire breed on calving from pure Holstein heifers and percentage of problems during calving

Breed of sire	Number	(%)	Stillbirth (%)
Holstein	371	16.4	15.1
Montbeliarde	158	11.6	12.7
Brown Swiss	209	12.5*	11.6
Scandinavian Red	855	5.5*	7.7*

Table 6. demonstrates that by changing the breed of bull used on Holstein heifers clearly affects the risk of calving difficulties. By using a Scandinavian Red bull, the calving difficulties are significantly reduced as well as the percentage of stillbirths. This would be a beneficial sire to use in organic systems as it has the potential to reduce the risk of calving difficulties, reducing the risk of intervention.

Table 7. also demonstrates the effect of changing the breed of bull, but this is on Holstein cows who have previously calved. Again, the Scandinavian Red has the most significant effect on reducing calving difficulty and reducing the percentage of stillbirths, but there are other sire breeds that also reduce the percentage of stillbirths (e.g. all of the sires listed except the Holstein). In these scenarios, farmers would select a sire based on reducing the problem being experienced on individual farms.

Table 7. Effect of sire breed on calving from pure Holstein dams and percentage of problems during calving

Breed of sire	Number	Calving difficulty (%)	Stillbirth (%)
Holstein	303	8.4	12.7
Normande	326	8.7	7.3*
Montbeliarde	2373	5.4	5.0*
Brown Swiss	524	4.9	5.6*
Scandinavian Red	515	2.1*	4.7*

Table 8. Effect of dam breed at first calving and percentage of problems during calving

Breed of Dam	Number	Calving difficulty (%)	Stillbirth (%)
Holstein	676	17.7	14.0
Normande x	262	11.6*	9.9
Montbeliarde x	370	7.2*	6.2*
Scandinavian Red x	264	3.7*	5.1*

Change in breed changes % of stillborn and calving difficulty.

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Table 8 demonstrates how a change in dam breed can affect the risk of calving difficulties. Here the Scandinavian Red and Montbeliarde cross have significantly lower risk of calving difficulties and stillbirths than the other breeds and crossbreeds.

Table 9. Effect of breed on survival and fertility

Breed of dam	Number	Calved by 14 months (%)	Days open
Holstein	86	44	156
Normande x	94**	62**	133**
Montbeliarde x	96**	64**	137**
Scandinavian Red x	93**	60**	142**

Table 9 demonstrates the value of hybrid vigour. There is significantly increased survival and better fertility in cross bred animals, compared with pure breeds.

Overall, tables 6-9 demonstrate how simple breed changes in both sires and dams can affect production. Although the tables above include data for Holsteins, this is included to illustrate a general point about breed selection, as Holsteins are not necessarily a good breed for organic systems.

Despite the risk, if careful management occurs crossbreeding can be beneficial (as demonstrated in section 2.3. Crossbreeding). Crossbreeding in dairy cows is useful providing milk yields are not adversely affected. Crossbreeding with breeds that add carcass conformation to their offspring are beneficial in the dairy sector as it adds value to male calves. Under normal circumstances, any bull calves that aren't being kept for breeding as essentially an economic cost to rear and sell. Crossbreeding allows these calves to be of more economic value and can be sold for beef. This is ideal in organic systems as some organic standards state you must have a plan in place for dealing with dairy bull calves. This crossbreeding gives access to a market for these calves, and a more economic justification for rearing and selling them for meat. However, this needs to be balanced against reducing other valuable traits in the female breeding stock such as lowering lactations and milk yield.

When investigating the value of crossbreeding for organic systems, there may be certain production characteristics which need improving. Examples of the various production characteristics for specific dairy breeds which may be advantageous when crossbreeding as shown in table 10.

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Table 10. Production characteristics for a number of dairy breeds

Dairy breed	Production characteristics
Maas-Rijn-Ijssel (MRI)	• Dual purpose • Stocky • Good milk from forage
Guernsey	• Docile • High fat content • Difficult to market calves
Jersey	• Similar milk solids %age as HF, but more efficient • Small cow, less soil compaction • High occurrence of milk fever • Good milk from forage • Effective grazer of coarse vegetation • Good grazer on sensitive swards or wet sites
Holstein Friesian	• Bred for production on concentrates • High milk yield • Difficult to market calves
Ayrshire	• High milk production • Milk with high butterfat content • Hardy • Difficult to fatten and market calves

3.2. Beef

Selection objectives within the beef sector are like those in the dairy sector in terms of young stock survival and reducing the risks associated with calving, but the overall production objectives differ between beef and dairy production. Beef systems are focused on meat and carcase conformation. Unlike dairy systems, both female and male calves are of equal valuable in beef farming, therefore production traits focused on increasing meat yields will be the main focus. Examples of specific traits which would be used in beef animals under grass-based systems such as organic, include:

- ✓ **High female fertility**

  Increased fertility in females means more offspring from single animals. Providing all offspring can be successfully reared within organic regulations, more offspring equates to more product to sell.

- ✓ **Longevity**

  If the breeding animals live longer, more offspring can be produced over their lifetime, increasing the economic gains across the farm.

- ✓ **Low somatic cell counts**

  This is linked to the risk of mastitis. This becomes more important in dairy stock but reducing the risk of mastitis in any organic system is beneficial as it allows organic regulations to be achieved.

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- ✓ **Lower body weight to higher body conformation score**

  Better carcase conformation equates to more economic value.

- ✓ **Animal health related**

  For example, famers would be monitoring and recording udder health, feet problems, locomotion and gait (described in section 3.1. Dairy). Animals with good scores in these areas would be beneficial for breeding stock (and production stock) in organic systems as it reduces the risk of illness and disease, leading to derogations.

- ✓ **Calving ease**

  By monitoring calving ease, calving difficulties can be reduced and ideally avoided. This is ideal in organic systems as it removes the need for veterinary intervention.

- ✓ **Temperament**

  Similar to those described in 3.1. Dairy, some level of reduced aggression reduces the risk to the stockperson and increases management ease.

As with the dairy system described above, different breeds can be crossbred into beef systems to provide specific production traits, depending on the farm's overall goals and objectives. Important traits and characteristics in organic systems may differ from conventional systems due to different management and husbandry practices used. A summary of those of greater importance in organic systems can be found in table 11.

Table 11. Production characteristics for a number of cattle breeds

Cattle breed	Production characteristics
Angus/Aberdeen Angus	• Healthy • Hardy • Finishes well on (improved) grass • Traditional Angus is hard to source
North Devon	• Hardy • Can finish off grass • Small animal; good in wet areas • Easy calving • Cows almost too fat • Traditional breed; good for direct marketing
South Devon	• Hardy • Good for low-input systems • Heifers finish in 20-22 months • BUT difficult to finish off grass under 30 months
Longhorn	• Can finish off grass, • Quiet, easy to handle • Slow maturing; finishes off grass at 4 years. Additional feed 6-8 weeks prior to slaughter can allow steers to be finished between 24-30 months
British White	• Easy calving

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Characteristics like hardiness, health and finishing well on grass are critical for organic beef farming systems. If the stock cannot survive outdoors, maintain their health and convert grass into meat/fat successfully, they won't be useful in organic systems which promote outdoor access, pasture-fed, and healthy livestock.

In beef systems, specific EBVs and breeding indexes become more important as they can be successfully used for selection, without having to consider their effect on milk yield like in dairy systems. Table 12 highlights the valuable EBVs for beef systems and demonstrates how they are linked to production characteristics.

Table 12. Summary of specific EBVs and the related characteristic which are useful in beef systems

EBV	Characteristic
Gestation length	Easier calving
Calving ease	
Birth weight	
200 day growth	Efficient growth
400 day growth	
Muscle depth/area	Saleable meat Lean meat yield
Fat depth	

These EBVs and correlated production characteristics would be useful in conventional beef production systems as well as organic systems. Differences occur with EBVs focused on animal health, where they may be used more in organic systems.

3.3. Sheep

Sheep farming can be dual purpose, with the production of both meat and milk. Production characteristics between milk and meat do share some crossover, as well as having more similarity to conventional practices.

3.3.1. Sheep Dairy

Sheep milk production plays an important role in some less developed countries as the high prices for dairy products allow farmers to achieve economic gains easily. In addition, in arid areas sheep milk is a key source of protein and calcium. They can also be important for rural development due to their low environmental impact, benefits to diversity and the value of the organic milk/dairy product market. Organic sheep dairy systems usually utilise harsh environment unfavourable for dairy cattle. The grazing of organic sheep dairy (and meat) systems promote traditional pastoral practices, preserving a cultural heritage and sustainability of rural communities.

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Studies on this subject have shown the positive effects of organic sheep milk production systems on product quality, animal welfare, animal health and environmental impact compared to conventional farming systems.

Organic dairy sheep systems may experience a lower milk yield than conventional systems, but their product can be classified as higher quality, and may attract a price premium. With sheep milk systems the same can be said. Low milk production can be associated with poor ability to adapt sheep dairy breeds to organic management, limited genetic potential in native and local breeds for milk production, and increased dependence on environmental conditions causing yields to vary. This is more acceptable in organic systems, as the aim of organic dairy is not maximise dairy productivity, but to allow organic production under specific management and husbandry practices which work in balance with the environment and the resources available.

Value traits and characteristics in organic sheep dairy are:

- ✓ **Feed conversion**

  This is critical for sheep dairy as the animal needs to consume enough energy and protein to support maintenance as well as milk production. With organic systems being more pastoral in nature, feed conversion is critical.

- ✓ **Somatic cell counts**

  Used to monitor and reduce the risk of mastitis.

- ✓ **Fertility**

  Organic systems have reduced inputs and certain chemical use is banned. Therefore, increased fertility through selective breeding if beneficial.

- ✓ **Lambing ease**

  Reducing the risks associated with lambing, allows organic principles to be maintained, with little external intervention.

- ✓ **Temperament**

  Similar to dairy cattle, dairy sheep require daily milking. To increase the ease of management, monitoring and selecting for docile, easy management/handling will reduce potential stress and animal health issues as well as reduce the risk to the operator.

It has been observed that breed and genotype of dairy sheep are the main contributor to milk yields and changes in chemical composition. Crossbreeding of specialised, native dairy breeds with other breeds allows improvements in production traits as well as increasing adaptations in feed conversion, climate adaptions and ease of management. Stock which are genetically adapted to environmental extremes will be more productive in these environments. Crossbreeding these breeds in organic systems will reduce production costs, lowering inputs and allow the system to be more sustainable. Examples of important traits in organic dairy sheep can be seen in table 13.

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Table 13. Important traits in organic dairy sheep and their heritability

Trait	Heritability
General disease resistance	0.05-0.80
Resistance to parasite infection	0.25-0.40
Somatic cell count	0.12-0.13
Longevity	0.05-0.13
Female fertility	0.07-0.20
Mature size	0.47
Feeding characteristics	0.10
Udder shape	0.20-0.24
Teat size	0.18-0.39
Milking ease	0.01
Milk production and composition	
Milk production	0.28-0.32
Fat content	0.41-0.62
Protein content	0.51-0.53
Fat yield	0.17-0.29
Protein yield	0.18-0.27

Data from: [21, 70-77].

3.3.2. Sheep Meat

Unlike dairy production, sheep meat production systems are not so critically concerned about milk yield reductions when establishing selection characteristics. They can focus primarily on fertility, lamb survival and growth rate. Examples of organic production characteristics for specific sheep breeds can be found in table 14.

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Table 14. Production characteristics for a number of sheep breeds

Sheep breeds	Production characteristics
Roussin	• Good in organic systems • Difficulties getting Roussin replacements
Dorset	• Fattens quickly
Suffolk	• Rams are highly rated as terminal sires for producing lambs for slaughter • Suffolk cross lambs are fast to mature
Welsh Mountain	• Welsh Mountain ewes X Longwool rams X (again) with a terminal sire breed produce a fat lamb for slaughter.
Jacob*	• Lambs are slow to finish
Black Welsh Mountain*	• Low maintenance breed in terms of husbandry although generally prefers quite good grazing • Small and quite hardy despite a delicate appearance • Extremely good, hard, slow-growing hooves • Foot-rot resistant; even on the wettest of grounds • Physically easy to keep and handle with few husbandry requirements • Can have some problems during lambing: if ewes have too rich a diet, big lambs are produced which can cause birthing difficulties. Lambs are normally born as twins and are small
Beulah*	• Good for conservation grazing. Shown to be a valuable tool in reducing the invasion of scrub on grasslands of conservation importance

Table 14 has taken certain sheep breeds and listed their characteristics which might be good in organic systems. Like beef production, sheep which produce hardy, healthy lambs that finish off grass should be well suited to organic systems.

One area breed characteristics of particular interest in organic sheep systems (both meat and dairy) is resistance to parasites. Due to management and husbandry methods used in organic systems, there is an increased risk of exposure to external and internal parasites, compared with conventional systems (i.e. increased access to outdoors particularly in summer months, the ban on prescriptive use of antibiotics and anthelmintics). The same can be said for organic dairy cattle with parasitic gastroenteritis in heifers being more prevalent and in outdoor pigs. Selecting breeds with resistance and resilience, combined with other methods for controlling parasitic infection, as discussed in Chapter Farm Management, should allow organic systems to avoid or reduce the risk of infection. A number of phenotypic traits are available for selecting resistance and resilience to parasitic infection which include faecal egg count (FEC), worm burden, serum antibodies, peripheral eosinophilia, packed cell volume, live weight, serum protein and albumin concentrations. Advantages of using these markers are summarised in table 15. Comparison of various small ruminant breeds (sheep, goats) and statistical estimates of the heredity of resistance has provided evidence for the genetic control of these traits.

Table 15. Advantages and disadvantages of phenotypic markers used to evaluate resistance in sheep

Phenotypic marker	Advantages	Disadvantages
FEC	Reproducible, heritable and reliable parameter for the assessment of the resistant/rapid recovery status of the animal. Having positive and negative correlations with other phenotypic parameters.	Time consuming and hard labour for low fecund nematode species. Identification of eggs in mixed infections especially trichostrongyle species is difficult through similar morphology
Worm count	Powerful aid in the verification of FEC outcomes and to minimize the uncertainty with respect to trichostrongyle species identification. Helpful for the study of abomasal histology.	Slaughtering of animals is mandatory, therefore expensive in terms of labor and cost
Fecundity and worm length	Correlated with parasitological and other phenotypic parameters. Helpful in understanding the mechanism of host resistance against gastrointestinal nematodes.	The study can be done at autopsy; therefore, it is costly and not routinely applied.
Periparturient rise	It is a simple and inexpensive method. It can be preferred because it can be applied easily in livestock farms.	A single feature is not sufficient to indicate the resistance state. Not valid for father and lamb selection.
Packed cell volume	Useful indicator in case of gastrointestinal nematodes. Routinely practiced along with FEC in most studies to identify the resilience status of animals.	Expensive Labour and much more time consuming
Blood eosinophils	It is a valuable indicator of parasitic infections. Correlates with routinely accepted parameters.	Labour intensive and expensive and not used in routine practice.
Total plasma protein level	It is useful in confirming parasitological and hematological findings and in determining protein loss, which is an important component of meat, wool and enzymes.	It is not routinely applied. Expensive in terms of both cost and labor.
Immunoglobulins	Useful to be familiar with the mechanism involved in resistance, and for confirmatory tests of other practiced parameters.	Not regularly practiced in poor and developing countries owing to expensive, also ordinary laboratories lack prerequisites of these tests.

Abomasal histology	Valuable to comprehend the locally involved resistance mechanism in the event of abomasum-residing parasites and to associate with parasitological and haematological parameters.	Applicable only at necropsy. Costly, laborious and not routinely practiced by researchers.
Anthelmintic treatments	Simple and supplementary parameter that can be considered in routine practice to minimize mortality.	Not practical when the number of animals or infection level is low.
Pasture infectivity	Th his can help determine pasture contamination, which is an indirect indication of host resistance status.	Not routinely practiced by different researchers.
Live weight	It is an indicator of economic losses of meat, which is routinely applied on a weekly and monthly basis in livestock farms.	Different breeds show different growth rates and are ineffective in this case; however, it is a valuable aid for comparing similar species of small ruminants and for determining within-genus variability in natural resistance to nematodes.
Wool growth	Valuable parameter for developed wool industries.	Not yet routinely practiced, particularly in developing and poor countries.
FAMACHA system	This application is inexpensive and can be used in routine practice. It also helps in slowing down anthelmintic resistance and rational use of dewormers.	Helpful in parasite infections
Histamine concentration	Valuable parameter of importance to confirm the findings of abomazal histology and IgE levels.	This is necessary for slaughtering animals for tissue histamine concentration. And so it is very costly when applied routinely.

Note: Not all parameters will be acceptable in organic systems

EBVs can also be used in sheep meat production systems to assist with selective breeding. EBVs are useful tools when selecting both sire and dam for future breeding stock as well as youngstock for rearing. Examples of useful EBVs for sheep production are summarised in table 16.

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Table 16. Summary of specific EBVs and the related characteristic which are useful in sheep meat systems

Maternal Ability	Maternal ability
Litter size	Prolificacy
Eight week scanning weight	Efficient growth
Scan weight	
Muscle depth	Saleable meat Lean meat yield
Fat depth	
Mature size	Efficiency
Lambing ease	Health and welfare
Birthweight	
Faecal egg count	

In both dairy and meat sheep farming, traits and characteristics of interest can also be linked to specific breeds. This is where crossbreeding can be used in organic systems to introduce specific traits, lacking in the farm's current systems (table 17).

Table 17. Summarises different traits (breed categories), describes their use and lists examples of sheep breeds which are useful for introducing these traits

Breed Category	Description	Example
General purpose	Good balance between sire and dam traits	Dorset, North County Cheviot, Montadale
Maternal	Good adaptability to more difficult environments; above-average fleece; primarily found in range areas	Merino, Rambouillet, Targhee, Columbia, Polypay
Prolific maternal	Very large numbers of lambs (average three or more per ewe); excellent newborn vigor	Finnsheep, Romanov
Sire	Large mature size; rapid growth; superior muscling; lower carcass fat	Suffolk, Hampshire, Oxford, Shropshire, Texel, Southdown
Dairy	Specialized for milk production	East Friesian, Lacaune
Hair (meat)	Don't have wool; adapted to hot, humid climates; parasite tolerant	Katahdin, Dorper, St. Croix, Barbados Blackbelly
Specialized or long wool	Produce colored fleeces or fleeces with other unique characteristics; desired by fiber artists	Shetland, Icelandic, Lincoln, Border Leicester, Romney
Hobby or rare	Not typically used for commercial production; may be raised for exhibition, breeding stock, or to preserve the breed; may possess traits of importance to production in the future	Jacob, Cotswold, Navajo-Churro, Gulf Coast Native
Table adapted from "Changes in the Sheep Industry in the United States." 2008. National Research Council. Chapter 2.		

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3.4. Goats

As with sheep farming, goat farming can be dual purpose, allowing the production of meat and milk. Systems which focus on either meat or milk will have different production objectives and therefore, different breeding programmes. Production characteristics between milk and meat in goats do share some crossover, as well as having more similarity to conventional practices.

3.4.1. Dairy Goats

Organic dairy goat farming is very similar to that of organic dairy sheep farming. It plays an important role in industrial countries and a key source of protein and calcium in arid regions, as well as promoting traditional pastoral practices and preserving a cultural heritage.

Milk yields can be compromised when other production traits are focused on during selective breeding, therefore care needs to be taken to avoid breeding inadvertently reducing milk yields too much. This is more acceptable in organic systems as the aim of organic dairy is not maximise dairy productivity, but to allow organic production under specific management and husbandry practices which work in balance with the environment and the resources available. Value traits and characteristics in organic goat dairy are:

- ✓ **Feed conversion**

  This is critical for goat dairy as the animal needs to consume enough energy and protein to support maintenance as well as milk production. With organic systems being more pastoral in nature, feed conversion is critical.

- ✓ **Somatic cell counts**

  Used to monitor and reduce the risk of mastitis.

- ✓ **Fertility**

  Organic systems have reduced inputs and certain chemical use is banned. Therefore, increased fertility through selective breeding is beneficial.

- ✓ **Kidding ease**

  Reducing the risks associated with kidding allows organic principles to be maintained, with little external intervention.

- ✓ **Temperament**

  As with dairy cattle and sheep, dairy goats require daily milking. To increase the ease of management, monitoring and selecting for docile, easy management/handling will reduce potential stress and animal health issues as well as reduce the risk to the operator.

In the UK, breeding values are not used for dairy goats and selection is conducted on phenotypes. The same is true across Europe that unlike in dairy cattle, there are limited central recording systems for breeding values in dairy goats making comparative datasets limited.

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Suggest that estimates suggest there is "There is a potential for higher genetic improvement in protein content and protein yield in the Alpine breed. Conversely, higher potential for genetic improvement in milk yield and fat content in the Saanen breed" Studies on EBV in dairy goats are limited and conducted on small data sets. Therefore, phenotypic selection is used.

For both organic meat and dairy production systems, traits related to fertility, climatic adaptations and longevity, and animal health are important for product quality, alongside economic traits, and animal welfare. However, as explained above, there is a severe lack of datasets for genetic variation in dairy goats, therefore, trait-based breeding is rarely used. Basic characteristics used are milk yields, milk contents (% of fat and % of protein) which directly affect the farmers' income. For example, table 18 summarises the genetic trends in certain goat dairy breeds relating to production traits.

Table 18. Genetic trends per year for production traits in several dairy goat populations

Country and period	Breed	Milk (kg/year)	Fat (kg/year)	Protein (kg/year)
France 1990-2000	Alpine	13.65	0.55	0.50
France 1990-2000	Saanen	12.53	0.48	0.46
USA 1995-2000	Alpine	8.63	0.19	0.11
USA 1995-2000	Saanen	6.99	0.32	0.23
USA 1995-2000	Toggenburg	0.59	0.04	0.06

This demonstrates that irrespective of country, certain breeds perform better and could be crossbred into organic systems to increase production traits as required.

Other traits such as somatic cell count, udder conformation, milking ability all related to ease of milking and animal health are useful but not as widely used in conventional goat systems. Organic dairy goat systems focus more on these additional traits to improve health and control disease risk in the herd. Control of parasites is similar to that explained in section 3.3. Sheep.

3.4.2. Meat Goats

Meat goats have similar breeding programmes as sheep meat production. Where available, EBVs shown in table 16 would apply to meat goats. However, as explained in section 3.4.1. Dairy Goats, significant and accurate datasets for goat production are limited.

There are opportunities for organic goat production systems, particularly in terms of grazing marginal land which is naturally organic. It allows farmers to increase their income as land doesn't need to be "converted." With increasing global demand for organic products, this helps bring down the costs of organic production.

Planned research in health and welfare, breeding studies in disease resistance, natural control of parasites through plants, improved surveillance and epidemiology of key production diseases and developments in livestock breeding have the potential to increase the value of organic systems.

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3.5. Pigs

Any breeding programmes for organic pig meat production must be based on different criteria to those for conventional pig production, as the organic principles require different traits to achieve optimum production.

Unlike other organic production systems, outdoor pig systems don't suffer from reduced production rates as a direct result of the animals spending more time outdoors. Studies have shown no significant difference in reproductive and growth performance measures of the outdoor systems vs indoor systems. This is due to the belief that outdoor systems have a higher mortality due to crushing or exposure to extreme weather. As sows are not farrowed in crates, higher mortality does occur in outdoor systems but not enough to significantly affect reproductive performance across the different systems.

There is also evidence to suggest that genotypic and environmental interactions in conventional and organic systems can affect growth rates and carcase quality.

In organic pig systems, investment in crossbreeding programmes is costly. Many organic pig farms are small scale, without the finance to fund such breeding programmes. As a result, most organic pig systems use breeds from conventional systems, which are bred under intensive management, focusing on characteristics such as increased litter size, high growth rates and low back fat thickness (Figure 1). In conventional systems, boars are selected on traits such as growth, leanness and feed efficiency and gilts/sows are selected for their reproductive traits such as litter size, longevity and mothering ability. Organic systems tend to focus on resilience and resistance to disease, resistance to environmental stresses, improved forage conversion etc., which conventional breeding programmes tend to rank as being of lower importance as they can be managed through veterinary treatments. There are options for organic systems to either buy in replacements from organic farms (Figure 2) or breed their own replacements (Figure 3) to allow traits with a more organic ethos to be introduced.

Figure 1. Diagram representing the use of conventional breeds as replacements in organic systems

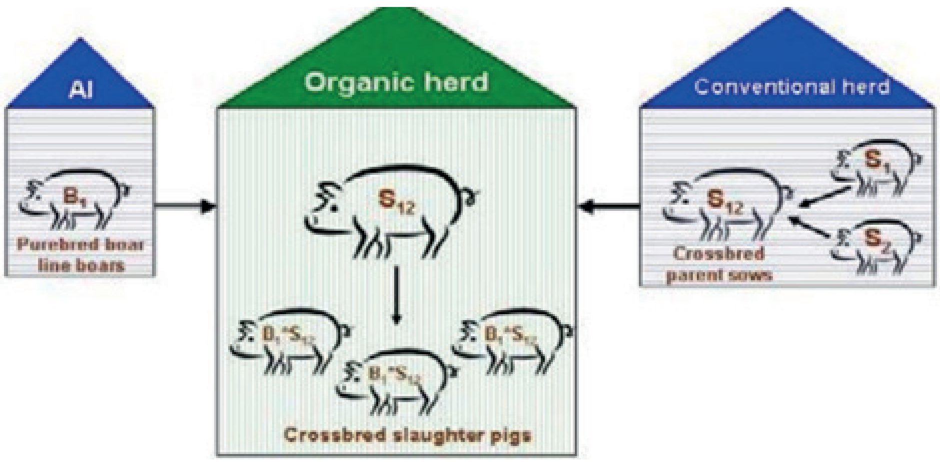


Figure 2. Diagram representing the use of gilts purchased from organic farms as replacements in organic systems

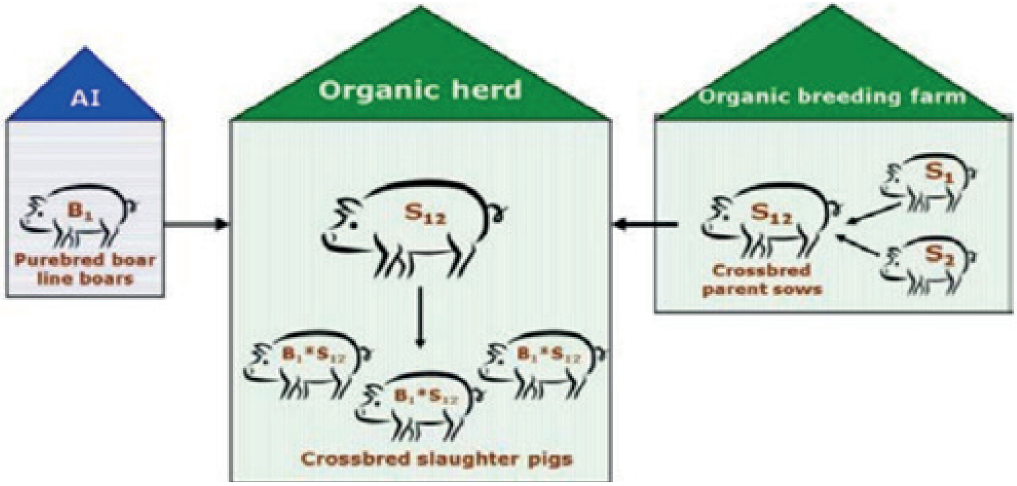
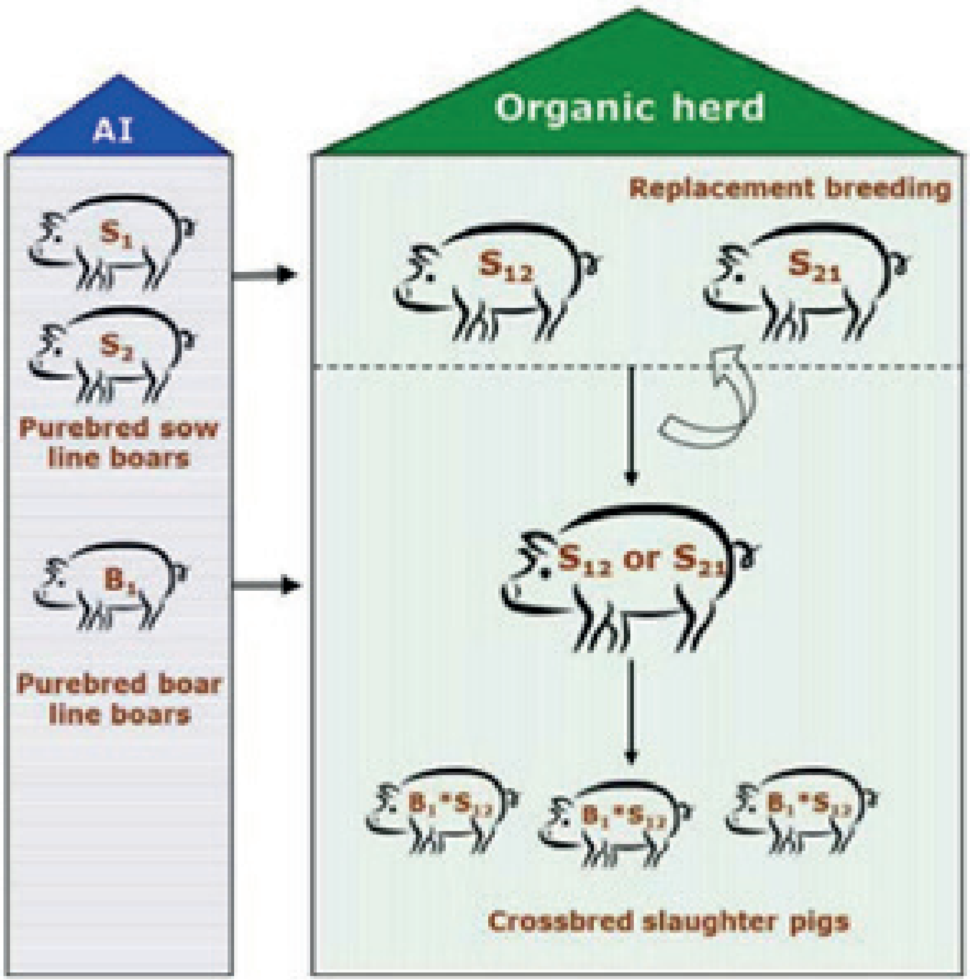


Figure 3. Diagram representing the use of homebred gilts for replacements in organic systems



As with the other livestock systems, choice of breed is very important in determining the future success of an organic pig system. Saddleback, Large Black and Mangalitza are classified as traditional breeds, and are often used on smaller scale farms such as organic or low input. A mixture of purebred stock and crosses with conventional sires such as Duroc and Piétrain seem to be the breeding strategies of choice for many organic farms. Whereas breeds such as crosses of Landrace, Large White and Duroc, as well as specialised genetic lines from breeding companies are utilised more in conventional systems.

In organic systems, breeds need to be able to thrive in the local climatic conditions, which vary across Europe, hence there are numerous porcine breeds used in organic systems. Table 19 summarises a few of the traditional breeds used in organic systems and the countries which use them.

Table 19. Breeds used in organic farms from different countries

Breeds used in organic farms	
Austria, Switzerland	Mostly conventional breeds used; sow: Large White x Landrace; boar: Pietrain (in Austria), Large White (in Switzerland); few exceptions using Duroc, Schwäbisch Hällisch or crosses of both
Denmark	Mostly conventional breeds; sow: Danish Landrace x Yorkshire, boar: Duroc
Germany, France	Mostly conventional breeds; Germany: sow: German Landrace x German Large White; boar: Pietrain or Hampshire x Duroc France: sow: Large White x Landrace, boar: Pietrain
Italy	50 % conventional breeds; sow: Large White, Landrace and Duroc (and hybrids), 50 % local breeds like Mora Romagnola and Cinta Senese
Sweden	Mostly conventional breeds; sow: Swedish Landrace x Yorkshire, boar: Duroc or Hampshire
United Kingdom	Small farms often use traditional breeds. Large farms generally use special outdoor lines that were developed for the conventional outdoor sector.

As explained above, conventional pig breeds used in intensive systems aren't generally well suited to organic systems, where more traditional, native breeds can be utilised to ensure organic standards are achieved. However, traditional breeds can be less advantageous due to low prolificacy, slow growth rates and a tendency to have excess fat at heavy slaughter weights.

Examples of the variation between conventional and traditional breeds when looking at key efficiency criteria can be found in table 20.

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Table 20. Performance of conventional breeds in comparison with traditional breeds in low input and organic systems

	Conventional breeds		Traditional breeds	
	Average	Range	Average	Range
Live born per litter (no.)	11.0	7.2-13.7	8.1	6.1-11.0
Mortality until weaning (%)	18.3	8.7-20.9	12.6	4.4-23.0
Weaned per litter (no.)	8.8	4.0-10.8	7.2	5.4-9.9
Daily gain (g/d)	782	658-927	540	250-750
Feed conversion ratio	3.0	2.6-3.5	4.1	3.0-5.8
Lean meat (%)	55.3	48.2-58.4	46.3	28.8-55.2

It is clear that breeds most suited to low input and organic systems have lower production "efficiencies" listed in table 20. As seen in other livestock systems, the focus in conventional systems is on production return to labour and capital, and output per sow per year, and breeding for these systems reflect these demands.

Organic systems favour other traits over simple production "efficiency" criteria.

Other considerations need to be made in terms of what type of meat is being produced commodity organic or premium organic pork. In addition, the type of pork being produced butchery pork or bacon and ham will affect the required carcase traits, particularly the fat content and quality which differ between various products.

This is a further reason for prospective organic pig producers to have identified and researched their prospective markets before embarking on an enterprise.

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UNIT 6

ANIMAL WELFARE and HEALTH

INTRODUCTION

In the context of the “One World One Health” campaign at the end of the last decade, the relationship between animal health and public health was once again under discussion. We will define the concept of “One Health”, health and disease, as well as the new concepts surrounding the issue. We will look at the interrelationship between the health of domestic animals and people, and also with wild animals. Because of the shared ecosystem (environment), genes and other topics in this module, exposure to disease can occur in agroforestry and pastoral systems. The concept of eco pathology, a discipline that examines the biological, physical, human, and economic causal elements of disease in livestock will also be discussed.

The second part of the module will focus on other non-infectious pathologies and the treatments permitted in organic systems, according to the new Regulation (EU) 2018/848. Conventional and alternative (green therapies) will also be discussed. The theory and experimentation on the role of homeopathy (pastures enriched with medicinal plants) will be explained. Biosecurity in agroforestry and grazing systems will also provide information on preventive medicine measures and the enhanced health factors in these systems. A specific focus on prophylactic methods to reduce parasite loads in grazing systems will be discussed.

1. "One World One Health"

"It has long been known that 60% of infectious human diseases are originating from animal (domestic or wild animals), Furthermore, 75% of human diseases are of animal origin." This highlights the opportunity to establish the link between animal and human health, not only in terms of public health.

This is why it is necessary for professionals from academic and industry must collaborate on food, health and disease. From veterinary medicine, agronomy, human medicine and nursing, as well as cross over in research and development. Joined up thinking needs to be utilised. In addition, the foundations of human health stems from "regular feeding of populations with wholesome proteins derived from milk, eggs or meat" highlighting the relationship between health livestock and health human diets.

It continues: "According to some assessments, global production losses due to diseases in animals within the food chain, are estimated to exceed 20%, suggesting that even animal diseases that are not directly transmissible to humans can cause serious public health problems because of the deficiencies in diets that occur."

In addition, in recent decades we have witnessed an exponential growth in the transit of people and goods worldwide (including animals and animal products), which increases the likelihood of global health alerts. The human population and its use of land is occupying new areas that were previously unexplored or sparsely populated. Contacts between wild and domestic animals or directly with people are increasing particularly in areas where previous interactions were limited. For the human population and its use of land is occupying new areas that were previously unexplored or sparsely populated. If we throw in the effects of climate change and potential new niches for species (especially insects which could be vectors of pathogens), we have the full picture of the health challenges we face.

According to Vallat, "the prevention of all these new dangers lies in a harmonious and coordinated adaptation of health governance arrangements at the global, regional and national levels." In other words, greater coordination of health alert systems, which is discussed at the end of this unit.

2. Health, Welfare and Disease

2.1. Concepts

The World Health Organization (WHO) defined health in the Introduction to its Constitution: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." This definition, which came into force on 7 April 1948, and has not been modified since then. Using the terminology, a "complete state", it is practically impossible for any person, animal or population to be considered healthy on the

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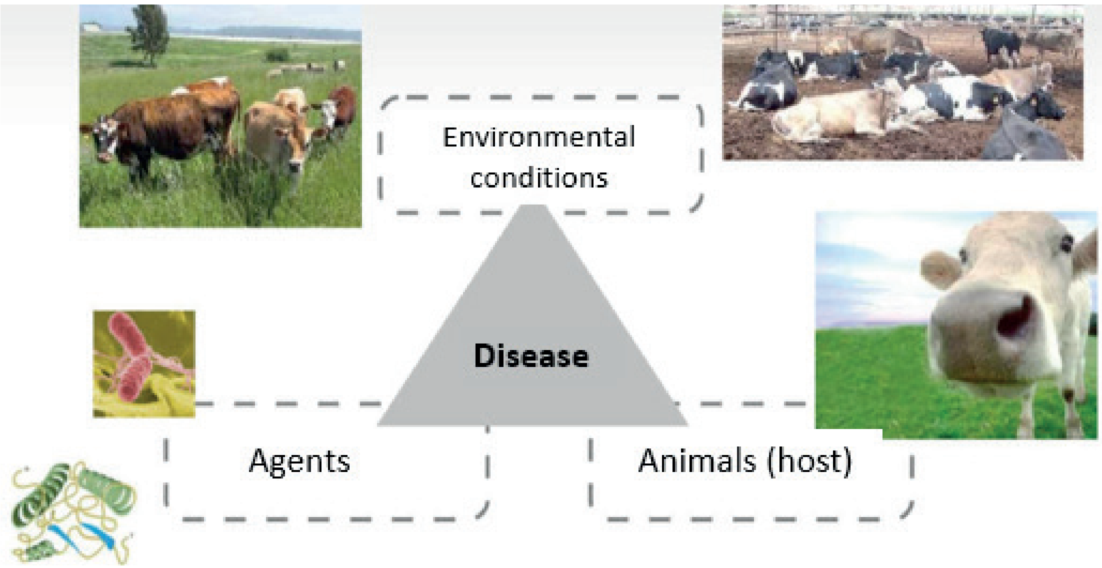
basis of this definition. An unofficial but more up to date definition is: "Health is the capacity for adaptation and self-management in the face of physical, mental and social challenges".

Therefore, health is not only the absence of illness but is the inclusion of a balance between health and illness.

2.2. Epidemiology

Using the definitions above diseases affect individuals differently due to both genetics and environmental components. If we add the agents plus the dynamic balance that is established between the three components, we have the health/disease triangle (**Figure 1**).

Figure 1. Health/disease triangle and interactions between animals (host), agents and environmental conditions



Consider disease as a consequence of an imbalance between the individual, the environment and the agent/s. This is the method with which epidemiology approaches the study of disease, health and its factors. This discipline, which is shared by human and animal health professionals, has many branches depending on the speciality e.g. veterinary, human, zoological, plant, ecological. In any case, they all deal with population diseases, i.e. potentially transmissible diseases such as infectious and parasitic diseases.

Infectious diseases stem from a microorganism (a living being of the Prokaryotic empires), bacteria, viruses and sub viral particles as well as prions (mad cow disease or Scrapie in sheep) and Fungi. Parasitic diseases are caused by agents (not always microbiological) of the Eukaryotic empire, i.e. whose singular base is the eukaryotic cell.

Of the parasites, it should be noted that some species complete their life cycle in the wild, where they tend to be more persistent. Some require intermediate hosts in which a different stage of development takes place than that of the definitive host. In the case of microbes, it is not intermediate hosts, but vectors, since life cycle development does not usually take place in them.

2.3. Hosts

The hosts in many cases domestic animals living in agroforestry and grazing systems, and their general health status will largely determine their predisposition not only to suffer from the disease, but also to be a carrier and therefore a source of infection. Factors that affect heath status can be:

- ✓ Nutrition and body condition.
- ✓ Physiological state: pregnancy, lactating - may suppresses the immune system to some extent.
- ✓ Prior contact with the pathogen: active immunity, either natural or artificial (vaccination).
- ✓ Passive immunity: by placenta or during lactation by immunoglobulins received by the neonate from the mother.
- ✓ Hereditary (genetic) predisposition. Indigenous breeds have co-evolved in a specific environment and with specific pathogens, and therefore have become more resistant.

2.4. Environment and Other Circumstances

Environmental factors influencing animal diseases in farming systems may include:

- ✓ Overcrowding.
- ✓ Sudden changes that trigger stress: poor handling during transport, sanitation, movement of livestock, etc.
- ✓ Extreme weather conditions.
- ✓ Soil and surfaces that animals interact with.
- ✓ Vehicles or items on the farm that could be vessels for pathogens.
- ✓ Feed quality.
- ✓ Water quality.

3. Health Surveillance

Surveillance and alert systems are established by governments and international agencies monitor the health status of human, domestic animal and wildlife populations.

Pathogens know no borders, which is why international coordination is necessary. At the apex of coordination are the World Health Organization (WHO) and the International Organization for Animal Health or Office International des Epizooties (OIE). These are connected to regional and/or national networks. In the case of the Spanish state, the Veterinary Health Alert Network (RASVE) is affected by the Ministry of Agriculture (each country has its own).

These bodies establish which diseases must be legally reported by medical practitioners (doctors and veterinarians) so that the appropriate control measures can be established to prevent the spread of the disease.

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3.1. List of Diseases of the OIE – Office International des Epizooties

Highlighted in black are those with current or potential relevance in farming systems. Each country will establish which diseases are present in the country using the reporting and surveillance systems.

3.1.1. Infectious Diseases

Brucellosis (Brucella abortus, Brucella melitensis, Brucella suis), Anthrax (Bacillusanthracis), Cowdriosis, Japanese encephalitis, Equine (Eastern) encephalomyelitis, Aujeszky's disease, Epizootic haemorrhagic disease, Echinococcosis/hydatidosis, Vesicular stomatitis, Foot and mouth disease, West Nile fever, Rift Valley Fever, Crimean-Congo haemorrhagic fever, Q fever, Bluetongue, Chrysomya bezziana myiasis, Cochliomyia hominivorax myiasis, Paratuberculosis, Rinderpest, Rabia, Surra (Trypanosoma evansi), Trichinellosis, Tularemia.

3.1.2. Bovine Infectious Diseases

Bovine anaplasmosis, Bovine babesiosis, Bovine genital campylobacteriosis, Nodular contagious dermatosis, Bovine viral diarrhoea, Bovine spongiform encephalopathy, Enzootic bovine leukosis, Contagious bovine pleuropneumonia, Infectious bovine rhinotracheitis/ infectious pustular vulvovaginitis, Haemorrhagic septicaemia, Theileriosis, Trichomonosis, Trypanosomosis (transmitted by tsetse), Bovine tuberculosis. A list of cattle diseases can be found at: https://www.nadis.org.uk/disease-a-z/cattle/.

3.1.3. Pigs Infectious Diseases

Porcine cysticercosis, Nipah virus encephalomyelitis, Swine vesicular disease, Transmissible gastroenteritis, African swine fever, Classical swine fever, Porcine reproductive and respiratory syndrome. A list of pig diseases can be found at: https://www.nadis.org.uk/disease-a-z/pigs/.

3.1.4. Goats/Sheep Infectious Diseases

Enzootic abortion of sheep (ovine chlamydiosis), Contagious agalaxia, Caprine arthritis/ encephalitis, Nairobi disease, Sheep epididymitis (Brucella ovis), Maedi-visna, endo- and ectoparasites of small ruminants, Contagious caprine pleuropneumonia, Scrapie, Salmonellosis (Salmonella abortus ovis), Sheep pox and goat pox. A list of sheep diseases can be found at: https://www.nadis.org.uk/disease-a-z/sheep/. A list of goat diseases can be found here: https://www.nadis.org.uk/disease-a-z/goats/.

For most of these diseases, information can be found in the OIE technical sheets: http://www.oie.int/es/sanidad-animal-en-el-mundo/fichas-tecnicas/.

Regulations:[4] The following regulations aid in controlling diseases in livestock:

- ✓ Commission Implementing Decision (EU) 2016/969 of 15 June 2016 laying down standard reporting requirements for national programs for the eradication, control and monitoring of certain animal diseases and zoonoses co-financed by the Union and repealing Implementing Decision 2014/288/EU.
- ✓ Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending or repealing certain animal health acts ("Animal Health Legislation"), with entry into force on 21 April 2021.
- ✓ Regulation (EU) 2021/690 of the European Parliament and of the Council of 28 April 2021 establishing a program for the internal market, the competitiveness of enterprises, including small and medium-sized enterprises, the area of plants, animals, food and feed, and European statistics (Single Market Program). With entry into force on 1 January 2021.

4. Principal Pathologies and Different Treatments

Most pathologies in livestock farming can be avoided through good management i.e. the origin of the pathogen depends on the decisions taken by managers. In extensive livestock farming where there is low input, infectious and contagious pathologies are the most common due to limited human intervention. There are still examples where human intervention can lead to infections occurring in extensive systems for example parasite exposure.

An example of non-infectious pathology that occurred mainly in the late 1980s, early 1990s was dystocia calving's in cattle. It occurred after the introduction of improved breeds through crossbreeding to increase commercial value but led to higher incidence of calving difficulties. Breed introduced included Charolaise, Limousine and especially Blonde d'Aquitaine, Asturiana de los Valles. A management change as simple as selecting sires for their calving ease (conformation) and avoiding in any case crossbreeding heifers with these better conformation sires reduced the cases.

The main diseases and health concerns in livestock in Spain were highlighted by in the "Organic Livestock Farming in the Dehesa" course (**Table 1**, Official College of Veterinarians, 12-17 November 2012, Cáceres). This was taken from 22 veterinarians, most of them practising in Cáceres (the province with the largest area of Dehesa in Spain). The methodology was experiential groups of 3-4 people where they shared their knowledge about the pathologies with the structure of the health/disease triangle: establishing the treatment and preventive measures at the three levels agent-host-environment according to their experience. The course evaluated the alternatives offered by homeopathic remedies, health plans and other complementary and alternative medicines which had been previously consolidated in the "Veterinary Green Therapies" course (April 2013, College of Veterinarians of Cáceres).

4 **Each country should indicate its regulations.**

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Table 1. Main pathologies in the Dehesa according to the students of the course[5]

		Agent	Host	Environment
Lameness	What	Fusobacterium, Dichelobacter, Bacteroides, strict anaerobes.	Sheep-goat, allochthonous breeds, wounds	Humidity, rainy seasons, stony soils, stables
	Prev		Native breeds. Pederex vaccine, Footvax vaccine, Australian vaccines, autovaccines	Hygiene facilities, bedding. Composting. Grazing according to environmental conditions
	Tto	Footbaths copper sulfate, formalin.		Disinfection. Quicklime.
Piroplasmosis	What	Babesia, Theileria, Anaplasma	Cattle, horses, dogs.	Ticks
	Prev		Cypermethrin (pour on)	Disinfestation: native chickens
	Tto	Buparvacuone, Dipropionate (Imizol)	symptomatic, iron, vitamin B, membutone,	Phytosanitary treatment.
White Muscle Disease	What	Poor pastures Selenium and Vit. E	Sheep, lambs, cattle.	Poor soils. Southwestern half of the Peninsula=dehesa.
	Prev		Vitamin Mineral Complex	
	Tto	Selevit and others.		
Enterotoxemia	What	Clostridium spp.	Sheep good body condition	Feeding changes. Fresh pasture dew, protein.
	Prev		Vaccination	Management
	Tto			

5 **Each country must establish what diseases are present.**

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Cryptosporidium	What	Cryptosporidium parvum	Sheep and goats. Perinatal.	Sheep and goats. Dirty litter. Spring. Overcrowding.
	Prev			Cleaning and disinfection. All in/ all out. Crusting.
	Tto		Systemic treatment	
Oestrosis	What	Oestrus ovis	Sheep	Spring-summer. Bedding
	Prev			Composting
	Tto	Closantel, traps with hormones.		Biological control
Pasterelosis	What	Pasterella spp	Ungulates	Overcrowding, poor ventilation, feedlots, wild coexistence.
	Tto	Sulfamides, Enrofloxacin, Florfenicol, Tetracyclines	Vaccination	Good conditions, dry bedding, abrupt changes, avoid humid areas...
	Prev			
Fasciolosis	What	Fasciola hepatica	Bovine, ovine	Humid areas, snails calcium-rich soils,
	Tto	Hepasil, Ivomec F, Diclorfom		Pesticides to target snails / insects. Control of water birds (e.g. ducks).
	Prev			Avoid waterlogged pastures.
Blowfly Strike	What	Flies	All	Wounds, summer, hygiene, bedding,
	Tto	Biological control.	Torvisco/a, diluted Ivermectin, Cypermetrins	
	Prev		Avoid traumatic actions, shearing	Composting.

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4.1. Drugs Prescription in Organic Farming

Organic livestock farming is regulated by the new Regulation (EU) 2018/848 of the European Parliament and of the Council on organic production and labelling of organic products. This aims to guarantee the integrity of organic production to consumers. It is indicated that the use of antibiotics and antiparasitic is very restricted. Their use is allowed only in specific cases where the use of phytotherapeutic, homeopathic and other products are not appropriate They are only used for the purpose of preventing animal suffering, never as a prevention.

The use of antibiotics is under strict conditions and under the responsibility of a veterinarian, who must set restrictions on treatments and withdrawal periods.

As indicated in the new Regulation (EU) 2018/848 the official withdrawal period after the use of antibiotics will be double the normal withdrawal period, as indicated in EU legislation, and should be at least 48 hours.

In addition, where an animal or group of animals receives more than three courses of treatment with chemically synthesized allopathic veterinary medicinal products, including antibiotics, within a period of twelve months (or more than one course of treatment if their productive life cycle is less than one year), the animals concerned and products derived from them may not be sold as organic products and the animals must undergo full conversion periods to be included as organic once more. This does not apply to vaccinations, anti-parasite treatments and compulsory eradication programs.

In order to avoid the use of antibiotics, antiparasitic and other artificial substances that stimulate growth, animal health management should focus primarily on prophylaxis, in addition to the application of specific cleaning and disinfection measures.

The European Union has high animal health and welfare standards, and in this context, antibiotic use play a very important role in safeguarding the health and welfare of both companion and production animals, as well as humans.

Management, biosecurity and hygiene are essential elements in the protection of animal health and welfare. However, despite all efforts, animals can still get sick and there will always be cases where animals need to be treated with antibiotics.

4.1.1. Responsible Prescription

Sensible use of antimicrobials should result in justified and selective use, thereby increasing therapeutic effect and reducing antimicrobial resistance. The end result of cautious use should be an overall reduction in antimicrobial use.

The responsibility for the careful use of antimicrobials lies with the prescribing veterinarian or the person who administers them. The veterinarian should be familiar with the history of the herd, flock or treated animal and with the current regulations. There are some regulations set to limit the use of specific antimicrobials such as Commission Delegated

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Regulation (EU) 2021/1760 of 26 May 2021 supplementing Regulation (EU) 2019/6 of the European Parliament and of the Council by establishment of criteria for the designation of antimicrobials to be reserved for the treatment of certain infections in humans.

According to the Commission Guidelines (2015/C 299/04) the prescription of antimicrobials should be justified on the basis of a veterinary diagnosis in accordance with the current state of scientific knowledge.

All information concerning the animal/s, the cause and nature of the infection as well as the available antimicrobials should be taken into account when deciding on antimicrobial treatment. The first choice should always be a narrow-spectrum antimicrobial unless previously performed antimicrobial susceptibility testing (epidemiological data) shows that it would be ineffective. The use of broad-spectrum antimicrobials and unauthorized combinations of antimicrobials should be avoided, especially in organic systems.

Antimicrobial treatment should be administered to animals according to the instructions given in the veterinarian's prescription. The pharmacovigilance system should be used to get information and feedback on therapeutic failures help identify potential resistance problems.

4.1.2. Some Considerations about Prescription in Organic Farming

Organic livestock farming has a number of characteristics:

- ✓ Conventional synthetic treatments may be used whenever necessary with a limit of three per year or once per production cycle.
- ✓ Organic livestock farms are subject to vaccinations or any compulsory action as a consequence of an official sanitation plan like any other farm, without losing their organic status.

4.2. Antibiotics and other Drugs Resistance

Antibiotics, which are closely monitored in organic farming, are one of the main tools for the treatment of bacterial diseases and can alleviate and prevent suffering. In the case of zoonoses, they even prevent infection in humans. However, the use of antibiotics also has detrimental effects, mainly caused by misuse or abuse.

We now have a wide range of products available for use in animals. Responsible use is our obligation and therefore we must establish disease monitoring and management protocols to reduce the use of.

The use of antibiotics in livestock is regulated and controlled by law to ensure that products reaching the consumer are safe and do not contain any harmful residues. Following European directives, Spain has created the Strategic and Action Plan to Reduce the Risk of Selection and Spread of Antibiotic Resistance developed by the Spanish Medicines Agency. The UK has established the Responsible Use of Medicines in Agriculture (RUMA) Alliance to help tackle antibiotic use (https://www.ruma.org.uk/).

In veterinary practice, this Spanish plan implies important restrictions on the use of antibiotics. It imposes mandatory veterinary prescription through electronic prescriptions to control antibiotic consumption. According to EU legislation, when animals need antibiotics, they can only be prescribed by the veterinarian, who will also be ultimately responsible for the correct application of the treatment, the animals must receive the optimal dose of antibiotic, for the time necessary to inhibit or eliminate the bacteria causing the infection or disease. The choice of antibiotic is made after an antibiogram whenever possible and following the legislation mentioned above.

There are no standardized doses or durations of treatment, and it should always be considered that treatment may itself cause new problems, even similar to those it is trying to combat. It is recommended to rotate drugs to avoid generating resistance, where possible. Reducing the duration of treatment or reducing the prescribed dose may affect the efficacy of treatment and allow resistant bacteria to survive. Therefore, antibiotics should only be used as described.

Withdrawal or withdrawal periods must always be respected or observed. When medicines are used in animals, a treatment register should be kept in which all details of the treatments and the animals to which they are administered are recorded.

It seeks to preserve the use of sensitive antibiotics in human medicine; for use against multi-resistant bacteria; leading to restrictions on their veterinary use.

In Spain, regulations require all healthcare professionals to report all Suspected Adverse Events (SAEs) due to veterinary medicinal products. For the proper functioning of a pharmacovigilance system, active participation of healthcare professionals, especially veterinarians, is essential both for their technical knowledge and their clinical activity.

Antibiotics Classification

Bactericides kill microorganisms. They act in the logarithmic bacterial growth phase. Examples include beta-lactams; aminoglycosides and fluoroquinolones.

Bacteriostatics inhibit bacterial growth. They act on the stationary phase of bacterial growth. Examples include Sulphonamides; Macrolides; Tetracyclines and Chloramphenicol.

Some antibiotics have a bactericidal or bacteriostatic effect depending on whether act in vivo or in vitro, and are affected by the dose administered.

The World Organization for Animal Health (OIE) presented a classification of antimicrobial agents of veterinary importance into:

- ✓ Agents of Critical Importance or AVIC.
- ✓ Agents of High Importance or AVIE.
- ✓ Agents of Importance or AVIM.

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The table published by the OIE International Committee contains information on drugs for all species.

The EMA has decided to modify the classification of these medicines in accordance with the risk that their use in animals causes to public health through the probable development of resistance.

4.3. Alternative and Complementary Medicine (ACM)

According to the National Center for Complementary and Alternative Medicine (CAM) (USA), CAM is "a group of diverse systems, products and practices of health and medicine that are not generally considered part of conventional medicine." However, for the American Veterinary Medical Association "there is only one veterinary medicine and a single standard must be established. All treatments and modalities must be judged by the same criteria and meet the same standards. Terms such as holistic, traditional, alternative, integrative or complementary that do not meet the established palliative quality should not be given special consideration when judging the safety and efficacy of such treatments."

The main advantages of these therapies would be:

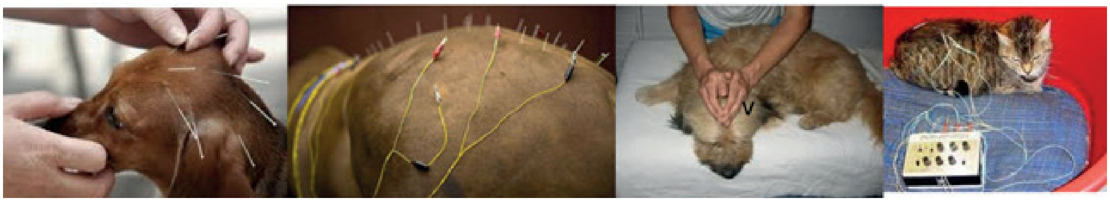
- ✓ Biodiversity: effective where others have already caused resistance due to massive use.
- ✓ Obligatory in the case of organic livestock farming. Regulation (EC) 834/2007 which orders them to be the first veterinary choice.
- ✓ Wide therapeutic margin.
- ✓ No waste for most of them.
- ✓ Economic.

The main disadvantages are:

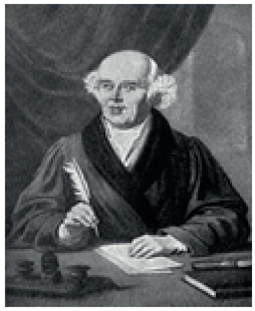
- ✓ Inaccessibility of many of these products and therapies due to lack of commercially available preparations or lack of dispensaries.
- ✓ In Spain there are no regulations on the training of technicians.
- ✓ Lack of knowledge on the part of veterinary practitioners and pharmacists.
- ✓ For developing in many cases inappropriate dosage regimens with possible adverse effects.

Alternative and complementary medicine (ACM) most commonly used in animals are: homeopathy, phytotherapy, aromatherapy, oligotherapy, hydrotherapy, clay, acupuncture, Bach flowers, osteopathy, chromotherapy, music therapy, Feng-Shui **(Figure 2)**.

Figure 2. Complementary Alternative Medicines (CAM)



4.3.1. Homeopathy



Homeopathy was invented by the German physician **Samuel Hahnemann**[6] (1790) who formulated the maxim: "like cures like" as the basis of effective medicine. According to Day (1995) the main benefits of homeopathy would be:

- ✓ No side effects.
- ✓ No animal testing requirements.
- ✓ No residues in tissues or milk.
- ✓ Availability and no withdrawal period.
- ✓ Low associated cost.
- ✓ Positive animal welfare effects.
- ✓ No dependence on conventional medicine for diagnosis.
- ✓ Non-immunosuppressive effects.
- ✓ Effective.

Today there is much debate in the scientific community about the efficacy of homeopathy, as the extremely high dilutions on which it is based assume that there are no traces of the product in the final dose according to Avogadro's number. Basically they are tested through scientific drug discovery routes, and therefore can't be promoted as such.

García Romero (2012) explains that low dilutions or potencies are generally used for chronic, local processes and high dilution for acute cases, parasitosis and/or, allergies. In any case, he warns that "veterinary homeopathy must be based on an accurate, detailed diagnosis in order to establish the most appropriate remedies." The same author recently designed an experiment to test the anti-parasitic efficacy of homeopathy. "Preliminary results indicate as a conclusion that in rainfed systems with proper grazing management, homeopathic application is sufficient and cheaper to control parasitosis linked to pasture, than the routine use of ivermectins, whose residues are harmful to human and environmental health by reducing the beneficial microbial biomass involved in the biological control of parasites."

6 Samuel Hahnemann's photo was taken https://tr.wikipedia.org/wiki/Samuel_Hahnemann.

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For Vicente Rodríguez Estévez (2011), a specialist in ethnoveterinary medicine (that which recovers the traditional use of plants and other therapies), homeopathy has serious limitations in our livestock context:

- ✓ It is a therapeutic culture that is foreign to both farmers and veterinarians.
- ✓ Homeopathic treatments are not readily available.
- ✓ Its effectiveness needs to be demonstrated to farmers.

Table 2. Main homeopathic principles and their general uses

Remedy	General Uses
Arnica Montana	Trauma, shock, impacts, bruises, contusions, sprains, bleeding
Apis	General oedema, fever without thirst, urticaria, itching, cystitis, etc.
Belladonna	Heat, flushing, pain, tumours, fever, hypersensitivity, etc.
Aconitum	Consequence of dry cold, very high fever, fear of something
Heparsulphur	Acute discharge or pus in wound, draining of abscesses with pus, hypersensitivity
Silicea	Chronic discharge or pus in wounds, hardening of the glands, weight loss
Cuttlefish	Problems of the female genital tract, hormonal problems
FerrumPhos	Cough and cold, fever
Cantharis	Irritant cystitis urine infections, burns, irritations, metritis
NuxVomica	Indigestion, diarrhoea, abdominal pain, colic, constipation
Gra graveolansroute	Shock and tendon injuries
Rhustox	Muscles and joints, cramps
Pdophyllum	Intestine, liver,
Berberis	Kidney problems, lower back pain, kidney stones
Alliumcepa	Colds with mucus, fever
Arsenicumalbum	Watery stools
Mercurius	Haemorrhagic faeces

Similarly, he also says that phytotherapeutic preparations are difficult to find and sometimes expensive, whereas homeopathy is more affordable and has simpler forms of administration, such as in drinking water or administered in small doses, whereas phytotherapeutic are administered as infusions or decoctions and require doses of 150-250 ml/ animal once or twice a day.

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Table 3. Frequent diseases in sheep and their homeopathic treatments

Disease	Treatment	Remarks
Acetonemia	Glucosaline serum with vitamin B1	With excellent results and no need for corticosteroids.
Reproductive disorders	Ovarium compositum+Homeel	Treatment of sex glands, ovaries and testes
Colibacillarydiarrhoea	Nux vomica+VeratrumH+ Mucosacompositum	2cc of each initially every
Non-dilation at delivery	Cuprum compositum	2-4 ampoules intravenously every 30-40 min. and traction
Lack of contractions	Caulophyllum I-F	2-4 ampoules intravenously
Low libido	Testis compositum	2-4 ampoules three times a week

4.3.2. Phytotheraphy

10% of all plants on earth have a beneficial effect on health equating to 25,000 medicinal plants available. Their therapeutic use is at the very origin of medicine and is as old as mankind. The ability of animals to select their food according to their needs is well known, and have been known to be self-medicate when disease presents itself. In fact, there is a current amount of complementary and alternative veterinary medicine that uses aromatherapy at the choice of the "patient."

In the metabolic process of plants, they produce primary or pure substances and secondary metabolites. The latter are of less physiological relevance for the plant, however, they are the ones with the most active ingredients, i.e. they have pharmacological activity (**Table 4**).

Some immediate principles such as carbohydrates, lipids, proteins and amino acids or their compounds such as polysaccharides or enzymes also have a strong therapeutic effect (**Table 5**).

Table 4. Basic active principles and pharmacological activity of some medicinal plants of veterinary interest

Components	Therapeutic properties	Medicinal flora
Thymol, carvacrol	Antimicrobial, antiparasitic, antiseptic, antitussive, antiseptic,	Thyme, oregano
Cineol, camphor	Carminative, choleretic, antiseptic	Romero
Eugenol	Microbiocide, fungicide	Lavender, dill
Camphene, terpene alcohols	Anthelmintic, anti-inflammatory	Femalefan palm

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Anetol	Antiseptic, carminative, anti-spasmodic	Green aniseed
Menthol, x-bisabolol, hydrocarbons	Digestive, carminative, anti-spasmodic	Mint
Camazulene, x-bisabolol, hydrocarbons	Digestive, carminative, anti-inflammatory	Camomile
Citronellal, geranial	Digestive, carminative, anti-inflammatory	Melissa
Borneol, geraniol, linalool	Digestive, carminative, antispasmodic, antiseptic, sedative	Lavender, lavender
Cindol, eugenol, linalool,terpineol	Antiulcerant, expectorant, expasmodic	Laurel
Anethole, anisaldehyde	Carminative, expectorant	Fennel
Eucalyptol	Antiseptic, axpectorant, balsamic, mucolytic	Eucalyptus

Table 5. Main medicinal plants for the most common phytotherapeutic treatments

Pathologies	Medicinal plants
Gastroenteric processes. Digestive and pulmonary parasitosis	Garlic, caraway, walnut, pumpkin, carrot, thyme, aloe vera, gentian, fumitory, peppermint
Ectoparasites: essential oils, dermal preparations	Rosemary, Eucalyptus, Thyme, Pine
Insect repellents, skin cleansing	Basil, thyme, olive oils
Skin ulcers or wounds	Calendula, thyme, laurel
Antiseptics, antimicrobials	Garlic, juniper, pine, heather
Trauma or contusions	Arnica, lavender, rosemary
Insecticides, myiasis	Blackthorn and juniper

4.3.3. Medicinal Herbs Enriched Grasslands (MHE)

The term Medicinal Herbs Enriched grasslands (MHE) has recently been developed by the Organic Farming group of the Wageningen University and Research Centre. It is a system for measuring the contribution to herd/flock health of grasslands.

It consists of assigning a value to the sampled plants with known medicinal properties (+1), those with no effect on animal health (0) and toxic plants (-1). Only those plants whose secondary metabolite or active principle was found in the aerial part according to the specialized Natural-Standard database were assigned a value. The MHE index is calculated by multiplying the value assigned to the species by their dry matter contribution to the grass composition and could vary from the most unfavourable -100 to the most favourable +100.

A relationship was established between fortified medicinal grasses and herd/flock health, through direct and indirect indicators (**Table 6**), and lower antibiotic consumption. An increase of 13.70 points in the MHE index corresponded to a decrease in antibiotic consumption of one dose per animal day per year.

Table 6. Cow and herd health indicators

Category	Level	Criteria	Reference	Value
Behaviour	Flock	Isolation individuals	Not the natural state in cattle	0 (good) 2 (bad)
	Individual	Alertness, curiosity, active herding	A healthy cow should be alert to auditory and sound stimuli, eyes and ears should be active.	
Muzzle/eyes appearance	Individual	Nose: Dryness/ dryness	Yellowish or greenish mucous discharge indicates disease	0 (good) 2 (bad)
		Dirt in the eyes	Dirt, discharge or excessive dryness.	
Layer	Individual	Cleanliness: gloss and uniformity.	Dirty, dull, dull, poor body condition, etc. These are indicators of disease.	0 (good) 2 (bad)
Posture/ crazy-motion	Individual	Agility in steps, balance	Poor posture or unsteady gait indicates problems such as laminitis.	0 (no) 2 (yes)
Faeces	Individual	Consistency	The dung should be 2-3 cm high (not too runny and not too solid) with small indigestible particles.	0 (good) 2 (bad)
Rumen	Individual	Rumination	40-70/minute	0 (>70) 2(<40)
		Repletion	A full rumen is an indicator of health.	0 good 2 bad

Table 7. Medicinal plants of the Dehesa and their properties[7]

Plant name		Family	Active ingredients	Medicinal properties
Scientist	Common			
Anthemis spp	Manzanillas	Asteraceae	Sesquiterpenes	Febrifuge
Avena spp.	Oats	Poaceae	Minerals (Mn, Fe, Zn) Flavones, phytosteroids. Vitamins A, B1, B2, E and D. Saponins. Carotenoids.	Tonic. Minerals. Astringent.

7 **Each country should establish which medicinal plants are present in their agroforestry systems.**

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Cichorium intybus L	Chicory	Asteraceae	Sesquiterpenes, phenols, flavonoids	Insecticide, hepatoprotective, antitriglyceride, antihypercyclic, antiuric, anti-bacterial
Cirsium spp.	Thistles	Asteraceae	Alkaloids, glycosides, flavonoids	Diuretics, antibacterials, larvae inhibitors.
Dactylis glomerata L	Cocksfoot or bentgrass	Poaceae	Sesquiterpenes	Estrogenic, kidney and bladder.
Equisetum arvense L.	Horsetail	Equisetaceae	Silicates, alkaloids, minerals, enzymes	Diuretic, osteoporosis, antibacterial, antioxidant.
Medicago spp.	Like alfalfa.	Fabaceae	Vitamins (A, B, C, K), proteins, antioxidants	Diuretic, hemostatic, nourishing, stimulating, tonic.
Mentha aquatica L.	Mint	Lamiaceae	Essential oils (terpenes)	Antiseptic, antispasmodic, astringent, carminative, cholagogue, emetic, refreshing, stimulant, stomachic, tonic and vasodilator.
Plantago spp.	Plantagos	Plantagina- ceae	Allantoins, vitamins (A, C, K) minerals (Ca, S, K) glycosides, T-factor, mucilage, tannins.	Expectorant, colic and food poisoning. Antidote, antiemetic, antipyretic and refreshing. Antibacterial. Haemostatic. Gastritis. Cystitis, sinusitis and asthma.
Taraxacum officinale Weber	Dandelion	Asteraceae	Vitamins (A, B2, B6, C, K, H) minerals (Fe, Ca, P, Mg, K) glycosides, carotenoids, terpenoids.	Antibacterial, cholagogue, depurative, diuretic, hepatic, laxative, stomachic and tonic.
Trifolium spp.	Clovers	Fabaceae	Phenol-glycosides, phytosteroids, flavonoids, coumarates, mineral acids, saponins.	Anti-spasmodic, detergent, diuretic, oestrogenic, expectorant, sedative and tonic.
Tussilago farfara L.	Horsenail	Asteraceae	Mycelium, alkaloids, tannins, glycosides, phytosteroids, hyperosides, polysaccharides, essential oils and minerals (Zn, K, Ca, S, Fe).	Antitussive, astringent, demulcent, emollient, expectorant, stimulant and tonic.
Valeariana officinalis L	Valerian	Valerianaceae	Sesquiterpenes, iridoids, essential oil.	Calming, sedative, antispasmodic, anticonvulsant.
Veronica agrestis L.	Pamplina basta, yerba gallinera	Scrophulariaceae	Flavonoids	Antihaemorrhagic,

4.3.4. CAM Regulations

In Europe[8]

There are a number of regulations regarding veterinary medicinal plant use in Europe. These are the regulation (EU) 2019/6 of the European Parliament and of the Council of 11th December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC, as well as Article 110 (which came into force 28th January 2022). This sets out the derogations for the use of alternative medicinal products. "The competent authorities may allow the use of an unauthorized immunological veterinary medicinal product within the Union." Article 115 indicates the withdrawal period after the use of an unauthorized medicinal product:

"Waiting time for medicinal products used outside the terms of the marketing authorisation for food-producing animal species, the specified waiting time shall not be less than:

- ✓ 10 days: for eggs.
- ✓ 7 days: for milk.
- ✓ 28 days: for meat."

"The veterinarian shall keep records: date of examination of the animals, identification of the owner, number of animals treated, diagnosis, drugs prescribed, doses administered, duration of treatment, recommended withdrawal periods" for at least 5 years.

Chapter V of that Regulation lays down the rules for homeopathic veterinary medicinal products, and states: 'For the use of such registered homeopathic veterinary medicinal products, national laws that also apply to registered homeopathic medicinal products pursuant to Directive 2001/83/EC of the European Parliament and of the Council must be followed and complied with.

Directive 2001/83/EC is the Community code for medicinal products for human use.

Commission Directive 2006/130/EC of 11th December 2006 implementing Directive 2001/82/EC of the European Parliament and of the Council as regards the establishment of criteria for derogation from the veterinary prescription requirement for certain veterinary medicinal products for food-producing animals.

8 **Each country should indicate its CAM regulatory standards.**

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Figure 3. Legal situation in the practice of complementary and alternative medicine in humans in European countries. Medical and non-medical qualifications. Some CAM therapies by qualified medical personnel only. And all therapists with official medical qualifications.

4.4. European Medicines Agency (EMA)

The current trend is to reduce the use of antibiotics (and other antimicrobials) and, in turn, to encourage and promote alternative and complementary measures for prevention and treatment, among which the so-called nutritional strategies (based on feed additives, natural extracts, fatty acids, immunoglobulins, probiotics, prebiotics and postbiotics), or bacteriophage therapy are being considered. EMA has a critical role in the authorisation of these new therapies, just as it has already regulated the use of antibiotics. The proposed classification now comprises four categories, from A to D:

- ✓ Category A ("Avoid") includes classes of antimicrobials not currently authorised in veterinary medicine in the EU. For these medicines, their usage in food-producing animals is forbidden and they may only be administered to companion animals in exceptional conditions.
- ✓ Category B ("Restriction") refers to quinolones, cephalosporins and third and fourth generation polymyxins. To reduce the public health risk, the use of such antimicrobials in animals should be limited.

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- ✓ Category C ("Precautionary") covers antimicrobials for which, generally, alternatives exist in human medicine in the EU, but in veterinary medicine there are only a few alternatives in specific indications. These antimicrobials should solely be used when there are no antimicrobials in Category D that are effective.
- ✓ Category D ("Prudence") is the lowest risk category. Antimicrobials which belong to this category can be used reasonably in animals. However, it should not be forgotten that unneeded use and long treatment periods should be prevented and group therapy should be limited to situations where individual therapy is not possible.

5. Biosecurity in Free Range and Organic Farms

Preventive medicine deals with disease prevention based on a set of actions designed to avoid or minimise disease episodes through physical, chemical, biological or monitoring measures.

Biosecurity is the set of measures practiced on a given farm or production unit to prevent the entry and spread of diseases and causative agents, thereby protecting animals to safeguard their health, welfare and, by extension, public health. In addition, the spread and adverse effects of existing diseases must be minimized. Biosecurity is often associated with physical measures. Hygiene is often associated with chemical or biological measures.

5.1. Health Programs

Health plans or programs are recommended and in some cases obligatory, and should be a standard practice in 21st century livestock farming. In their implementation we must monitor their suitability and, above all, the cost-benefit balance.

Livestock health plans should have the following objectives:

- ✓ Strengthen animal defence mechanisms by developing agro-ecological and bio-zootechnical management.
- ✓ Restoring physiological normality of imbalances with the help of natural therapies.
- ✓ To limit and if necessary eliminate as much as possible zootechnical stress by applying good husbandry practices (the cause of 80% of health problems).
- ✓ Preserve the environment and its biological diversity by applying agro-biozootechnical measures that allow for the integration of animals into the natural environment and a sustainable balance with biotic agents.

5.1.1 Grazing Safety

For the adoption of appropriate measures in extensive systems, where the use of facilities is minimal, it is necessary to take into account the biotic and abiotic conditions of the agro-ecosystem in which the farm is located, as it is essential to know the risk factors according to epidemiological cycles and thus apply the right measures at the right time.

For example, in the Mediterranean-continental climates of the agrosilvopastoral systems, there are two periods of intense rainfall in spring and autumn and a very dry summer which, with proper livestock management, will allow for sanitary cleaning by solarisation of our pastures.

Some better practises

- ✓ All in/all out on pasture or alternating species (not sheep and goats which share parasites, especially lung parasites).
- ✓ Clean pastures for young or pregnant animals.
- ✓ Animals with low parasite loads or dewormed at introduction to the farm. Quarantines are essential general measures.
- ✓ Consuming grass over 5 cm whenever possible.
- ✓ Avoid early morning, cool and/or dewy pastures.
- ✓ Gradual feed changes, to enter feedlot for at least one week.
- ✓ Maximum one week in the same grazing area to avoid reinfestations and closing of biological cycles. See SCOPS for further details: https://www.scops.org.uk/internal-parasites/worms/alternatives-to-anthelmintics/.
- ✓ Waiting time of 60-90 days before returning to the same plots of pasture which will also allow the pasture to recover.

How to resolve unhygienic problems in the pastures?

In grassland management, three types of strategies are recommended: preventive, avoidance and dilution.

Preventive management consists of obtaining parasite-free animals by medication from parasite-free pastures. However, it has its limitations in terms of ecology and medium to long term consequences. Regular worming of sheep is not recommended. This option cannot be practiced on organic farms where preventive medication is not allowed and should not be used in non-organic systems. Furthermore, this procedure may lead to the selection of resistant nematodes as those that survive anthelmintic treatment are the ones that colonise the new pastures after weaning.

Avoidance grazing means that herds/flocks of susceptible animals are moved to clean pastures before they can be re-infected. If the pasture is contaminated at weaning time the animals will inevitably become infected after winter. In the case of nematodes the excretion of eggs in the early season will lead to high contamination in spring or autumn as we have seen above. This increase in infection levels can be avoided by moving animals to a clean pasture (an area previously used for agriculture or fodder production). **Alternate grazing** of different species, i.e. exchange of pasture between cows and sheep, can be considered as evasive grazing. Recent studies indicate that movement to clear pasture can be successfully carried out without the application of anthelmintics, but only if Haemonchus is not present.

Dilution grazing means that susceptible animals are always or alternatively grazed with immune animals of the same species or with animals of another species. Alternative or mixed grazing with sheep, horses, pigs and adult cows is considered as a dilutive control measure. Mixed or alternate grazing is more effective for nematode control in sheep than in cattle. Adult cows are always more protected against digestive helminths, as they are naturally less susceptible than sheep, as with more infective larvae are destroyed in the mucosa of their digestive tract. For this reason, adult cattle should always be the first to enter the agro-ecosystems grazed in previous years, in order to remove as many larval stages from the pasture as possible and reduce the level of contamination. Moreover, with this management, due to the feeding behaviour of cattle, there is always enough dry matter left for sheep feed. On the other hand, sheep and horses should be the first to enter clean grassland.

Other practices in arable lands

Drainage: Although liver flukes (fasciolosis and dicroceliosis) are not very common in agro-silvo-pastoral systems, especially the former, any measure aimed at reducing waterlogged areas in pastures (a prerequisite for the development of developmental stages and mollusc intermediates) is welcome. In this respect, pasture drainage is of most importance for the control of Dicroecelium*,* as although there is a second intermediate host, ants, control measures on this host are not advisable or feasible in many cases.

Rotations: Agricultural alternatives with cereals and legumes make it more difficult for parasites and other infectious agents to develop in the grassland, as they help to break biological cycles, as well as to create clean, parasite free pasture.

Fallow land: Interspersed fallows in rotations create sanitary gaps that prevent the development of the larval stage of many gastrointestinal and some lung parasites, reducing the risk of infection of livestock when grazing.

Plant species balance: In newly created grassland, the balance between legumes and grasses must be maintained so as not to encourage larval migrations of parasites to the grasses. Weeds and reduce the levels of contamination in grazing. The legumes chosen should be low in oestrogens and anti-nutritional principles, so as not to induce abortions and other nutritional pathologies in livestock.

5.1.2. Biosecurity on Farm

Minimum biosecurity measures must be observed in the construction of housing and handling facilities:

- ✓ Avoid pens and housing close to public roads.
- ✓ Limit access especially to rooms where feed and other sensitive products are stored. If possible without prior passage through the rest of the facilities for feed trucks or other supplies.

- ✓ Correct orientation of the facilities to avoid prevailing winds, excessive sunshine and waterlogging. This means building on high ground, East-West (or South-West-North-East) orientation and sheds open to the South or South-East in the case of wintering housing, which allows direct sunlight on the litter. If they are for summer use only, they can be oriented North-South to reduce UV levels.
- ✓ Use appropriate materials and designs for each installation to avoid excessive moisture build-up on floors and walls.
- ✓ Footbaths on the roads.

5.1.3. Biosecurity of the Animals

Chronic animals need to be culled and there is always the risk of asymptomatic carriers. Using a serological screening program could be an initial high cost with great benefits.

When a new animal arrives, a quarantine of at least three weeks in a separate place (isolation from current livestock) should be carried out and whenever possible serological checks and/or prior veterinary examination should take place. Health status, health reports and references from the farm of origin of the animals should be requested.

In terms of animal vector control, there are a number of key measures to be observed:

- ✓ Deworming of cats and dogs living with meat animals at recommendations of the local vet. This will aid in controlling parasitosis such as hydatidosis and toxoplasmosis.
- ✓ Prevent access of domestic and wild animals (rodents, birds) to feed shed, silos, animal sheds etc. Especially where hay or feed is stored. Physical barriers (grids, mesh) and rat extermination program should be used where rodents could be a problem. Rodents are also part of the trichinosis cycle, so their control in pig farms is of great importance.

5.1.4. Feeding, Hay and Silage

It is advisable to carry out regular controls to avoid the appearance of mycotoxin-producing fungi such as aflatoxins or bacteria such as Listeria in supplementary feeds. Apart from the biosecurity measures to be taken during storage (dry and isolated place and contamination controls), there are a series of considerations to be taken into account in the preparation of both hay and silage.

Hay

For proper tedding, the moisture content of the forage must be reduced to less than 16% in the shortest possible time. Desiccation and solar radiation are key to sanitise the grass from larvae and other pathogens. Excessive exposure to sunlight also deteriorates certain nutrients and therefore reduces the nutritional quality of the hay.

The quality of the hay depends basically on three factors:

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- ✓ The state of maturity of the plants at the time of mowing. The ideal time is when there is 10% flowering in the pasture or meadow.
- ✓ The method of mowing, curing and harvesting.
- ✓ Climate at the time of conservation.

Silage

Silage is a technique for the wet preservation of fodder in an acid medium, obtained from lactic fermentation caused by the development of certain microorganisms under anaerobic conditions. Its correct preparation makes it possible to safeguard the nutritional value of the plant, limiting losses in quantity and quality, avoiding the formation of toxic substances and the proliferation and survival of agents that are potentially pathogenic for animals. Adequate silage must reach an acid pH <4, and a temperature of 60 to 70ºC, as this maintains the nitrogen value and digestibility of the forage and inactivates the larval stages and eggs of parasites.

The keys to quality and hygienic silage are:

- ✓ Choose the optimum time for mowing: the higher the intake capacity and digestibility of the initial forage, the higher the nutritional value of the silage. As a reference, in the case of first-cycle grasses, the optimum mowing stage is at the beginning of gleaning. In the case of legumes, it is at the beginning of sprouting.
- ✓ Finely chop the fodder so that it compresses and keeps well (**Figure 4**). Practical recommendations are that chop sizes should be 2 to 4 cm for grass, and 90% of the particles should be less than 1 cm for feed maize.
- ✓ When climatic conditions do not allow adequate fermentation, use enzymes, yeasts and/or bacteria (in the case of organic production, products listed in Annex V of Commission Implementing Regulation (EU) 2021/1165 of 15 July 2021 authorizing certain products and substances for use in organic production and establishing lists thereof). Against this background, it may be appropriate to sow a sufficient amount of lactic acid bacteria to achieve ideal silage conditions from the start. In cases where the fodder to be preserved is low in sugars, it may also be advisable to use enzymes.
- ✓ Minimise air in the silage. The forage should be compressed properly with the tractor and the cover should be re-tensioned 15 to 20 days after preparation.
- ✓ Consumption of the preserved silage should not be immediate, but at least 3-6 months to ensure the death of all pre-infecting stages of parasites.

Figure 4. Chopped fodder for silage

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5.1.5. Water

Most animals have 60-70% water in their tissues. It is essential for metabolism, transport, thermoregulation, excretion and many physiological processes. It is the main food. Therefore, the water for the animals on our farm must be of good physical, chemical and microbiological quality (**Table 8**).

Throughout the year, water should be supplied from water troughs distributed throughout the agrosilvopastoral system, preventing animals from drinking from natural watercourses, and limiting livestock access to riverbanks, marshes, etc., to reduce the real risk of contamination and sharing watering places with wildlife.

The pH must be close to neutral, have low levels of total solids, be free of nitrites and nitrates, coliform germs, salmonella and other pathogens, contaminating residues of pesticides. From the hygienic and sanitary point of view, periodic controls must be carried out to check the qualities and correct certain deviating values if necessary.

Table 8. Normal water quality parameters

Components	Values	Remarks
Turbidity Units	0-5 UTN	Established by the WHO
Organic materials	Absence (<0-3 mg/L)	Oxygen demand index
pH	6.5-8.5	Neutrality ranges
Total dissolved solids	<500 ppm TDS	
Hardness	<50 ppm	Calcium and magnesium content

5.1.6. Carcases and Manure

Regulation (EC) 1774/2002 of the European Parliament and of the Council of 3rd October 2002 lays down health rules concerning animal by-products not intended for human consumption (ABPs) and was subsequently replaced, without major substantial amendments, by Regulation (EC) 1069/2009 of the European Parliament and of the Council of 21st October 2009.

Article 24 of Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3rd October 2002 derogates from the general arrangements for the disposal of animal by-products.

5.1.6.1. Composting

Compost is the product of aerobic decomposition of organic matter. It is a high quality fertilizer and the best way to complete the matter cycles. Composting can be done in piles or on the surface (**Figure 5**). On the surface, waiting times must be respected before animals are put in.

The ideal temperature conditions are achieved by means of the piles around 60ºC. When we do not apply artificial heat it would be cold or passive composting as opposed to hot or active composting. The humidity must be between 40 and 60%, so in very rainy climates or seasons it will be necessary to cover the piles and in dry season to irrigate it. The ideal C/N ratio (in dry matter) is between 25/1 and 30/1. We must therefore balance the manures richer in N (pigs and litter) by incorporating dry matter such as straw, pruning remains, leaves, etc. Oxygen must be present throughout the process to avoid anaerobic processes. The most usual method is 1m wide by 1m high piles with mechanical turning.

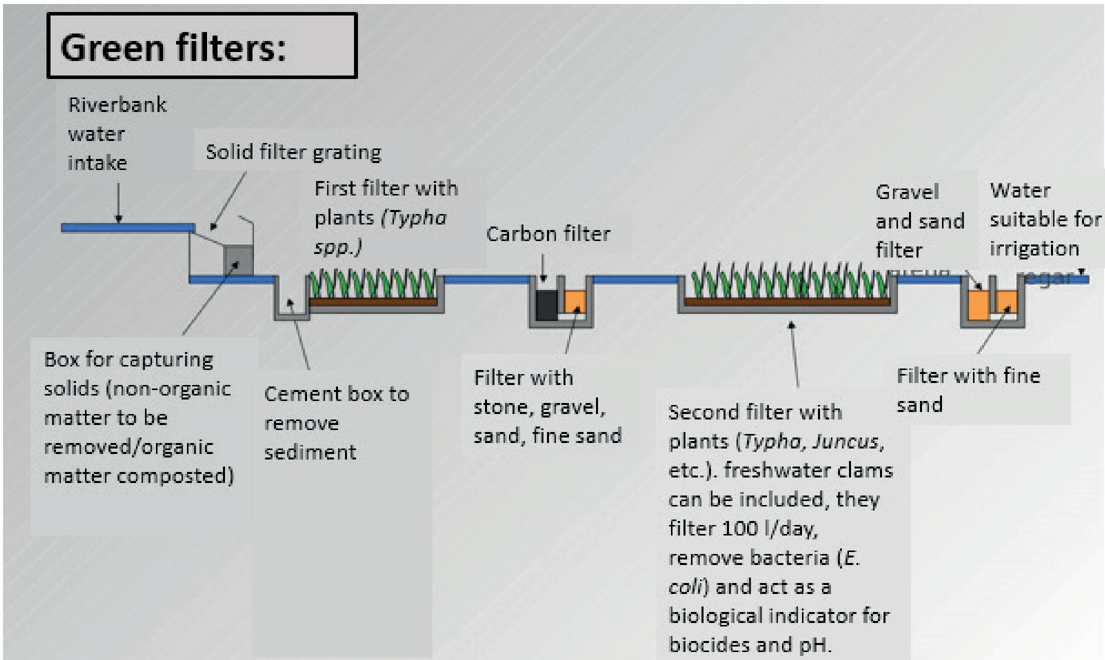
Figure 5. Two methods of windrow composting

Good manure composting is very important for manure hygiene, as the high temperatures reached (up to 70°C), which are a direct consequence of the aerobic fermentation processes, result in a high mortality of eggs and larval stages of parasites before they are spread on the pasture. As a result, the grassland is not contaminated, the biological cycle of pests and parasites is interrupted and the risk of contagion by grazing animals is reduced.

5.1.6.2. Grey Water: Green Filtering

Green filters are based on the capacity of the watercourses themselves with the help macrophytes, algae and microorganisms in the purification of greywater. They can be useful for the purification of water in areas that are difficult to access and for reclaiming ponds and other surface runoff. An example of a green filter is shown in the figure (**Figure 6**).

Figure 6. Green filter. Irrigation and manure hygiene workshop



5.2. Cleaning and Disinfection

Cleaning and disinfection of housing, fomites and in general all utensils is very important for the elimination of pathogens especially in the all-in/all-out process.

Some gastrointestinal nematodes, such as Strongyloides, Ascaris or Trichostrongylidae have no direct intermediate hosts in their life cycle, so larval stages develop in the facilities under high temperature and humidity conditions. Designing and implementing strict cleaning and disinfection protocols is essential to reduce the presence of these pathogens.

Manure and litter challenges must be removed mechanically. Cleaning with detergents and hot water is advisable but not always possible in extensive organic installations (**Table 9**). Quicklime is the most widely used and practical disinfectant, easy to transport and apply, and it enriches the manure with calcium, which is necessary for poor soils.

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Table 9. Accepted disinfection products in organic livestock farming.

Chemicals	Biologicals
Bleach	Citric and acetic acids
Lime, quicklime and grout	Dairy whey
Nitric, phosphoric acid	Calendula and echinacea
Formaldehyde	Natural essences: rosemary, juniper, thyme

5.3. Biological Control

Sometimes the agronomic measures mentioned above or solarisation itself, as well as rational grazing measures are not sufficient to eliminate parasites or pathogens in general from a pasture, especially for flying insects, biological control systems can be a good option, although many are still under development (**Table 10**).

One example is the use of poultry for insect control on livestock farms, which can be great allies in livestock housing for insect control by consuming fly larvae, nematodes and ticks (**Figure 7**).

In high stocking density management systems, broilers or laying hens are used in mobile and electrically netted poultry houses (**Figure 7**), 3-4 days after the herds, which is sufficient time for insect larvae and nematodes to develop in the cows' faeces. Apart from high quality protein, birds managed in this way:

Figure 7. Mobile poultry house. Domestic fowl as allies in pest and vector control. Plaw Hatch Farm. UK.

- ✓ Reducing the pest load of pastures.
- ✓ Spread the dung to accelerate composting.
- ✓ Facilitating solarisation.
- ✓ Reducing grass rejection by ungulates in the next round.

Bioecological studies on ruminant faeces, particularly bovine faeces, have identified numerous species of beneficial fungi, predators, competitors of pre-infecting stages of trichostrongylids and others nematodes, such as: Drechmeria coniospora, Arthrobotrys spp., Monacrosporidium spp., Verticilium spp. (egg predator) and Duddingtonia spp., including D. flagrans, which is effective in orally administered biopreparations. As its chlamydospores are highly resistant to the gastric juices of ruminants, they pass through the digestive tract intact and act on pre-infecting larvae in faeces, with a reducing effect in stool cultures that results in a decrease in pasture contamination by infective larvae (L3) of close to 100%.

In tick infection, biological control is focusing on entomopathogenic fungi, and there are Cuban and Spanish-American experiments tackling the bovine tick Boophilus microplus. Using bio-preparations with Verticilium through uniform sprays to cattle, a good level of pathogenic action is observed against eggs, larvae and adults. In addition, this mechanism is enhanced by some species of entomophagous ants and wasps of the genus Ixodiphagus, which also exert effective control against ixodids by parasitising their carnivorous larvae to feed on different larval stages of the tick.

In blow fly larval infections, and other insects, although there are live agents competing with the free environmental stages (pupae), attractant effects (pherohormones) combined with cage traps in suitable habitats and housing, can be effective in fly control. There are also natural essences, many under experimentation, which produce hormonal and physiological changes, affecting the growth, development and sexual maturity of insects, and therefore also exert an effective population control. An example of this is the juvenoids of the conifer Abies balsamea (juvaniona) and basil (juvocimenos), inhibitors of insect metamorphosis, such as the juvenile hormone, which causes sexually immature individuals and infertile and non-viable eggs in adults. Azadirachtin from the Azaridactia indica tree (Neem tree) is another natural substance that inhibits the moulting process and has insecticidal, acaricidal and nematicidal properties.

Table 10. Biological control of flies in the different phases of the life cycle

Egg	Larva	Pupa	Adult
Beetle (Carcinops pumilio) Habitat: beds, dry manure.	**Mite** (Carcinops pumilio) **Mite** (Buscuropodavegetans)	**Wasps** (Spalangiaendius Muscidifuras raptor) Habitat: biological development in manure. Carnivorous larvae of pupae.	**Domestic insectivorous birds** (ducks, chickens, etc.)
Mite (Macrocheles muscae domesticae) Habitat: litter, external parts of fresh manure.	**Slurry fly** (Ophiraaenescens) Habitat: surface slurry crusts.		**Adhesive tapes**
	Bacteria (Bacillusthurigiensis). Biopreparation. Larvicide.		
	Insectivorous birds		

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6. History of Veterinary Medicine and The Perception about The Animal Welfare

Major milestones in the history of veterinary medicine:

- ✓ Kahun Papyri (20th century BC): esotericism, minerals and plants.
- ✓ Code of Hammurabi (18th century B.C.): Art. 224 and 225 fees and indemnities.
- ✓ Chou Dynasty, China (10th century BC): the first official veterinarians.
- ✓ Sun Yang (7th century BC) 77 acupoints on equines.
- ✓ Greece: Pythagoras (600-500 BC), Hippocrates (460-377 BC) and Aristotle (384-322 BC) can be considered the pioneers of medicine (including veterinary medicine) in the West.
- ✓ Rome: The first "veterinaries": Dioscorides (first great thesis on phytotherapy, used today) and Columella (first agronomic thesis that also dealt with animal health issues) both from the 1st century AD, Galen (131-200 AD).
- ✓ Renaissance: Paracelsus ("all my knowledge of witches"). Andrés de Laguna (1499-1568) translates Dioscorides into Spanish.
- ✓ Western veterinary: First official veterinary school in Lyon 1761.
- ✓ Homeopathy: Hahnemann (1755-1843).

In 1965, the international standards of the World Organization for Animal Health (OIE) were established, indicating that animal welfare means "the physical and mental state of an animal in relation to the conditions under which it lives and dies." The OIE in the field of terrestrial animal welfare, stated a set of guidelines, "five freedoms", to describe the rights that are the responsibility of man, these are

- ✓ Free from hunger, thirst and malnutrition.
- ✓ Free from fear and anxiety.
- ✓ Free of physical and thermal discomfort.
- ✓ Free from pain, injury and disease.
- ✓ Free to manifest natural behaviour.

As a summary we see that veterinary medicine has always been closely linked to human medicine and that chemical pharmacology is actually relatively recent compared to the more than 4,000 years of written knowledge about phytotherapy. Nowadays we are working on the concept of "One Health": one health, animal health and welfare, the health of mankind and the environment.

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UNIT 7

REPRODUCTION

INTRODUCTION

Reproduction is the key to any livestock production, especially in meat production. All direct income will depend on the farmer's ability to increase reproductive rates, which depend on the importance of natural resources and the breeding plan itself in sustainable extensive systems.

In this unit we will review the anatomical and physiological reproductive basis of food animals, taking cattle as a reference. Then we will focus on practical aspects of reproductive management of animals in organic agro-silvopastoral systems, where natural methods of reproduction must be used, although artificial insemination is allowed as the only artificial method, and cloning and embryo transfer are totally forbidden. We will therefore carry out reproductive management based mainly on observation and knowledge rather than on technology, since the peculiarities of the extensive system are not the most appropriate for technification: recognition of oestrus, mating, gestation and its diagnosis, calving, udder and lactation and finally the first stages of breeding.

In spite of this minimal technification, throughout the text we will study examples of reproduction and breeding technology, new or old, but which are giving good results in the different species we have been dealing with: cattle, sheep, goats and pigs: male effect, flushing, gestation diagnosis.

In many cases we are going to advance contents related to nutrition, behaviour. Reproduction is the last vital function and it is a "luxury" in nature, so that only when the rest of the animal's needs are completely covered will there be the circumstances to achieve the highest reproductive rates.

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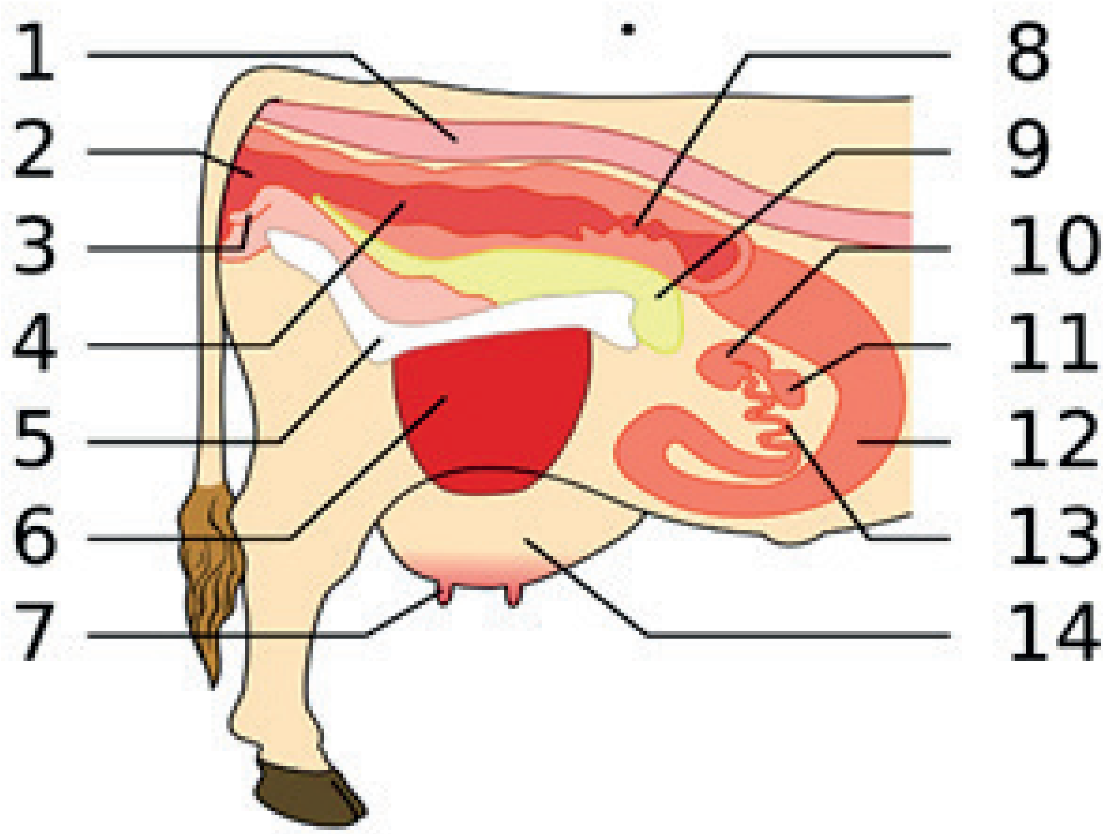
1. Anatomy and Physiology of Reproduction

The reproductive system of animals, whether birds, mammals or fish, consists of gonads, ducts and external reproductive organs. The gonads (ovaries in females and testes in males) are the organs responsible for producing the gametes, i.e., the reproductive cells, called spermatozoa in the case of males or ova or oocytes in the case of females (**Figure 1**).

Figure 1. Female mammalian reproductive organs. 1. Rectum 2. Vulva 3. Clitoris 4. Vagina 8. Cervix 11. Ovary 12. Uterine horn 13. Oviducts 14. Mammary gland



Both ovaries (except in birds where the ovary and the right oviduct are not developed) have an endowment of follicles that mature (see ovarian or oestrous cycle below). When the follicle reaches its last stage of development on the surface of the ovary, ovulation takes place, i.e. the release of the egg which is deposited in the first part of the female reproductive tract (infundibulum of the oviduct or uterine tubes) where fertilisation takes place, where appropriate, when it meets the spermatozoa which will have ascended through the reproductive tract from the vagina or uterus, depending on the type of coitus or insemination. The zygote (the result of the union of the egg and the sperm) immediately begins to differentiate (morula) as it descends through the body of the oviduct and the oviductal isthmus that connects it to the uterus (horns, body, neck) where it comes into contact with its mucous membrane, on coming into contact with its highly vascularised mucosa (with many blood vessels) it implants and as gestation

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progresses the placenta, the embryo and finally the foetus will form, when all the organs of the future neonate are formed.

The cervix separates the uterus from the vagina, where the urethra (which carries the urine from the kidneys) ends and where the penis is lodged during sexual intercourse. The vulva is the external sexual organ of the female where the labia vulvae can be seen and in some species (especially the clitoris in the case of the mare). In birds, the cloaca serves as the external sexual organ, as well as the end of the digestive and urinary tracts.

Table 1. Number of mammae of the different domestic species and their location

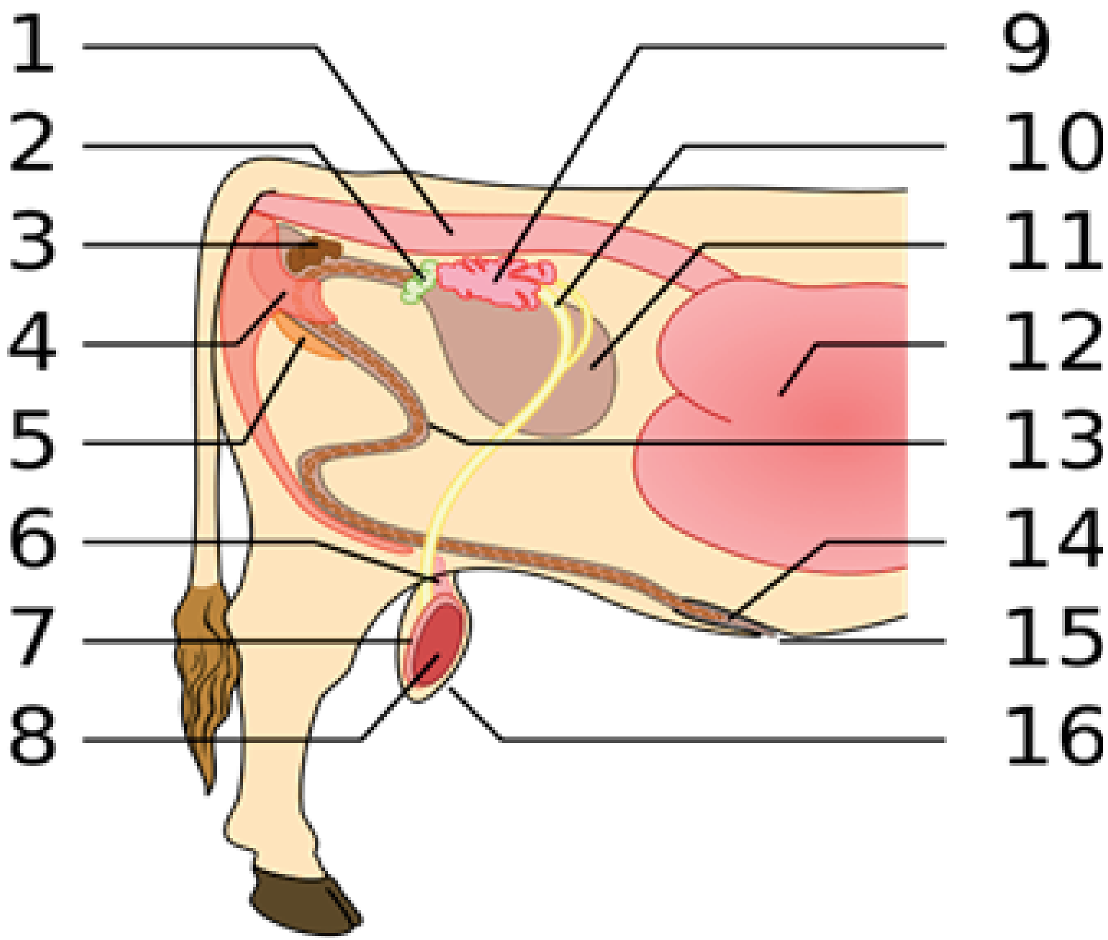
Species	Glands	Location
Mare	2	Inguinal
Sheep-Goat	2	Inguinal
Cow	4	Inguinal
Sow	8-14	Thoracic and abdominal
Dog-Cat	6-12	Thoracic and abdominal

The mammae or udders are the mammary glands (**Table 1**) that are distributed bilaterally along the thorax and abdomen in polyparous (multiple birth) species or 2 or 4 inguinal glands in other species. The udders are responsible for milk production, which is essential for the development of the new-born and milk in the case of dairy farms.

In the male the gonads are suspended in the scrotum, because for spermatogenesis to take place properly the testicles must be a couple of degrees Celsius below body temperature. From each testicle via the epididymis, the vas deferens originate and join at the urethra. The urethra empties through the urinary meatus into the glans penis. The skin covering the glans penis is the foreskin (**Figure 2**).

The reproductive adnexal glands responsible for the production of the nutritive and suspension substances that complete the sperm together with the spermatozoa are the seminal glands, bulbourethral glands and the prostate gland. There are three parts of penis in terms of erectile function: skeletal muscle, fibrous muscle and cavernous. Starting from the end, in the horse's penis the erectile function depends entirely on the blood system that will fill the corpora cavernosa. Ruminants and pigs have a fibrous muscle penis, with an S-shaped inflection, known as the sigmoid flexure or penile "S", which is capable of unfolding and allowing the organ to elongate out of the sheath at the time of mating. Rams and billy goats have a final elongation of the urethra that protrudes from the glans: the vermiform appendage, important for uterine ejaculation rather than vaginal as would be the case in horses and pigs, which allows for lower seminal dosage and therefore more coverings. Horses and pigs ejaculating in the vagina have to produce a greater quantity of semen, reducing the number of services to one or two a week to ensure good sperm quality. This is the reason why artificial insemination is especially profitable in these species as an essential requirement to reduce the male/female ratio that would be necessary in natural mating.

Figure 2. Reproductive organs of male mammals



1. Rectum 2. Prostate 3. Bulbourethral glands 4. Ischiocavernosus muscle 5. Bulbocavernosus muscle 6. Cremaster 7. Seminal vesicle 10. Ductus deferens 12. Rumen 13. Sigmoid flexure 14. Glans penis 16. Testis

In breeding males, it is advisable to carry out a mass and individual motility test of the ejaculate and spermatozoa, to ensure that there is no basic infertility or low seminal quality. It is advisable, in any case, to acquire stallions that have undergone a productive testing programme carried out by CENSYRA stations, producers' associations or breeders. In this way we will have guarantees of their genetic quality not only based on the stud book. These individual testing programmes are usually based on controlled systems of productive performance among congeners in similar circumstances. Breeding and selection programmes for indigenous breeds usually include, or even facilitate, the incorporation of male or female breeding stock into these selection schemes.

As mentioned before, the maturation of the follicles can be continuous (in polyestrous females) or discontinuous (monosex females) stopping during anestrus. For example, females have two ovulations per year as they have a very prolonged anestrus of about six months while cows are continuous polyestrics (ovulating every 21 days), unlike other females such as sheep which are seasonal polyestrics: once they come into oestrus they have consecutive ovulations for a certain period but have a more or less pronounced anestrus depending on several intrinsic factors (of the animal) or extrinsic (of the environment).

Once ovulation occurs, we move from the oestrous phase of the ovarian cycle (where oestrogen is the predominant hormone) to the luteal phase (more progesterone production) (Table 2). The latter phase is named after the corpus luteum, i.e., what remains of the follicle after the egg is released. The progesterone produced in this phase helps gestation (if fertilisation has taken place) by preventing the onset of a new cycle. If the zygote does not implant in the uterine walls, the corpus luteum will be lysed and the oestrous cycle will begin again.

Intrinsic factors influencing anoestrus:

- ✓ Domesticity, as wild animals tend to be more seasonal. For example, the seasonal oestrous cycle of the wild boar versus the continuous cycle of the pig.
- ✓ Race.
- ✓ Age.
- ✓ Feeding. For example, underfeeding breaks the cycle.
- ✓ Body condition. Excessive fatness affects the oestrous cycle.
- ✓ Pathological conditions: persistent corpus luteum, ovarian cysts, tumour processes, freemartinism (sterile females born from a twin birth with at least one other male).
- ✓ Reproductive status: for example, not all species do not become pregnant during lactation (see section 4).

Table 2. Types of ovarian or oestrous cycles and most significant characteristics for mating

Species	Oestrous cycle (days)	Type of cycle	Epoch cycles	Post-heat delivery (days)	Ovulation according to oestrus	Mating
Cattle	21-22	Continuo	Annual	35-80	10-14 hours	End of rutting
Equine	18-24	Seasonal Polyester	End of winter and spring	9	1-2 days before end	2-4 days before end
Sheep	16-17	Seasonal Polyester	Summer and autumn	At weaning	Final	16-32 hours after start
Caprine	20-21	Seasonal Polyester	Summer and autumn	At weaning	Final	16-32 hours after start
Porcine	20-22	Continuo	Annual	At weaning (4-6 days)	30-40 hours start.	0-24 hours after onset
Canine	180	Monoestric		At weaning	Days 9-14 after start	Alternate days between 9-14.

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Extrinsic factors:

- ✓ Presence of male: “male effect.”
- ✓ In other non-organic systems, hormonal treatments such as “vaginal sponges” for oestrus synchronisation are possible, but in organic systems the use of hormones is prohibited.
- ✓ Latitude, because as we get closer to the equator, the seasonality of the season decreases (**Table 3**).

Table 3. Anoestrus in sheep according to latitude

Region	Days anoestrous
Northern Europe	215-259 days
Mediterranean	51-131 days
Tropic	0 days.

- ✓ Photoperiod. As the days become shorter (negative or decreasing photoperiod) or as the length of daylight hours increases (positive or increasing photoperiod), the libido of the males changes and the oestrous cycle is activated. For example, small ruminants have a negative photoperiod or short days, i.e. ewes and goats normally become pregnant from summer onwards until winter. While mares and other equids come into heat in spring. It all depends on the gestation period, so that births occur naturally in spring.
- ✓ Presence of offspring.
- ✓ Animal welfare constraints: temperature, noise pollution, irritant gases, etc.

To reiterate what we mentioned in the summary: a very thin female will take longer to come into heat than a well-fed one, but with a good supplementation (**flushing**) a few days before putting her back in contact with the stallion (**male effect**) (**Figure 3**). This will be discussed in more detail in section 4.

Figure 3. The male effect works particularly well in native breeds. Herd of black merino owned by the author. Finca Fuente Teresa, Robledillo de la Vera, Cáceres, August 2012.

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2. Methods of Heat Detection

During oestrus a series of characteristic psychosomatic manifestations known as oestrus occur. These are changes in behaviour and in the external sexual organs that allow us to choose the ideal moment for mating, in the case of reproduction by directed natural mating (see section 4) or by artificial insemination.

For the farmer, the detection of oestrus is crucial to increase the profitability of his business, especially in dairy cattle, intensive pigs and in studs, as females and stallions are not usually together. Apart from possible production losses by increasing the time between pregnancies, artificial insemination is often used. Therefore, the precise timing of the oestrous cycle must be known in order to improve reproductive efficiency.

There are analytical, animal and visual methods for the detection of oestrus. Among the analytical methods we highlight ultrasound techniques, histiological (vaginal cells) or even movement monitoring using cameras. We are going to focus on the methods that require our participation to a greater extent: visual methods and the use of other animals.

2.1. How to Identify

2.1.1. Horses

- ✓ Search for the male.
- ✓ Raise the tail to one side with the male present.
- ✓ Urination in the presence of the male.
- ✓ Vulvar winks.
- ✓ It can be ridden by the horse.
- ✓ Males are often used to check if the mare is in heat.

2.1.2. Cows

- ✓ Restlessness, mooing.
- ✓ Discharge of vaginal mucus. This mucus gains consistency as the oestrus progresses.
- ✓ Very evident vulvar oedema.
- ✓ Allows to be mounted and mounts other females.
- ✓ Alteration of eating habits.

In dairy cattle it is common to take advantage of the fact that the cows mount each other, and some of them are fitted with a lumbar marker that stains the rump at the time of mounting, so that we can identify which cow has been mounted.

2.1.3. Goat and Sheep

- ✓ Concern to male.
- ✓ It deflects the tail and allows itself to be mounted.
- ✓ Vulvar oedema and cervical mucus.

In sheep and goat flocks, especially in dairy flocks, grouping of lambings by natural methods such as the **male effect** and **flushing** for oestrus synchronisation is often sought, as the use of hormones is forbidden in organic systems.

2.1.4. Pig

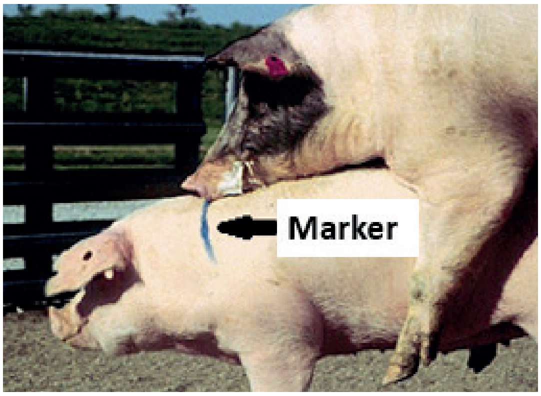

Figure 4. Effect of the marker placed under the male's jaw to identify females that have already been covered

Figure 5. Immobilization reflex when pressure is applied to the back of a sow in pigs

✓ Decreased appetite.

✓ Grunting and change of behaviour. Vulvar oedema, discharge of whitish mucus at the end of oestrus.

✓ Erect ears.

✓ Immobilisation reflex.

In the presence of a boar, as explained above, the operator rests on the sow's lumbar region and if the sow remains still, this means that she is at the optimum time for covering.

In summary, in addition to visual identification of behavioural changes related to oestrus, other techniques can be used:

✓ Markers on the male. For example, on the underside of the jaw, which will impregnate the female during mating (**Figure 4**).

✓ Markers on the female. Usually painting devices attached to the rump.

✓ Immobilisation reflex (**Figure 5**). In pigs as explained above.

Recella males, which do not cover, may have been vasectomised but never castrated in order to maintain the production of their gonadal sex hormones, which are crucial for reproduction.

3. Mating

The aim of mating is the fertilisation of the egg and subsequent gestation, which is key in any animal production cycle. It is a very important production phase in which many aspects of the facilities and the animals must be taken care of.

The sexual behaviour of domestic animals has changed greatly from that of wild animals, but still retains elements of wild animals in terms of territoriality, social structure or selective relationship. For example, dominant males do most of the mating and in any case are usually the first to cover. It is usually the female that selects the male, a phase in which human intervention has perhaps been most noticeable, as we shall see below.

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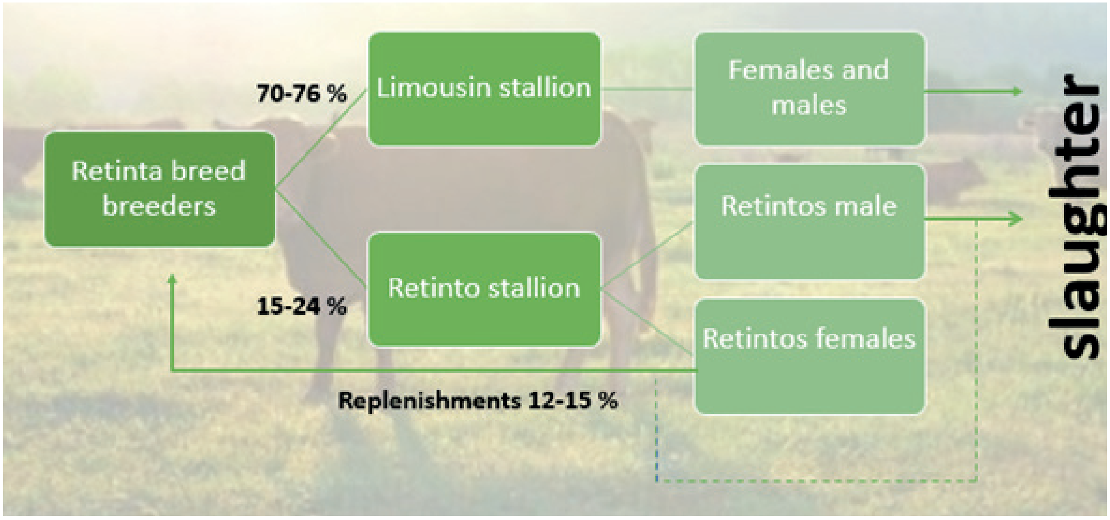
For our part, when we do not have a tested animal as we saw in point 1, the choice of the male will be based on productive, health and livestock management criteria. A sire that transmits high production rates to his offspring is of no use if the offspring will have health problems even at calving, as is typical in the industrial crossbreeding of certain breeding sires with native cows. In addition, selection with herd management in mind will be of great importance for extensive breeders where grazing is a fundamental part of the production process (**Figure 6**). In the latter case, artificial insemination is not usually used and therefore our intervention will be of:

- ✓ Anticipation: change males to avoid inbreeding; timing of stallions: see male effect; male/female ratio (see Table 4).
- ✓ And of control: fights, pathologies in reproductive organs.

Figure 6. Selection and crossbreeding scheme in a beef herd of native dams with Limousin industrial cross



3.1. Timing and System of Mating

The success of mating depends on multiple intrinsic and extrinsic factors as we have seen in section 2. Depending on the species and breed of our animals, we have to decide the most suitable age for the first mating of nulliparous females (those that have never calved). Sexual maturity varies between species, breeds and individuals. Too early mating may compromise the proper physiological and anatomical development of the female, which may subsequently lead to calving problems or shortening of the reproductive life of the animal. On the other hand, the longer the time without reproductive life, the lower the economic profitability of our farm. This is also a determining factor on the farm if the period between calvings is too long in the case of primiparous females (which have already calved once) or multiparous females (with two or more previous calvings).

Precocity refers to an age at which animals reach sexual maturity at a younger age than usual for that species. This implies not only reproductive but also productive issues, as from that time onwards a greater fattening starts and therefore the efficiency of the fattening decreases. An example of selected early breeds is the Friesian cow for dairy cattle or the British breeds for beef cattle. However, the more rustic native breeds (Merino sheep, Serrano goats, cows of the most diverse breeds, etc.) reach sexual maturity at a later age.

In addition to these factors, the oestrous cycle will be a determining factor, which is highly influenced in some species (sheep, goats, horses, etc.) by the photoperiod and, in short, the season of the year, as we have already explained. Thus, in sheep and goats the first mating will always take place at the end of summer/beginning of autumn, so we have to take into account from which farrowing pen we are most interested in leaving the replacement, in order to adjust the age to the aforementioned parameters: adequate age, minimum maintenance cost, empty females (**Table 4**).

Table 4. Recommended age of first mating in females and ratio males/females for free-breeding in native breeds in an extensive regime

Species	Age at first mating	Male/female ratio
Sheep-Goat	11-12 months	1/20
Cow	18-24 months	3-5/100
Porcine	8-12 months	1-6/10
Rabbit	4-5 months	1/10

Sexual maturity is also influenced by body condition. Generally speaking a sow is considered fit to be covered when she has reached at least 70% of the live weight of an adult. For example, in the case of sows no less than 90-110 kg which is usually reached at around 7 months in the case of early breeds.

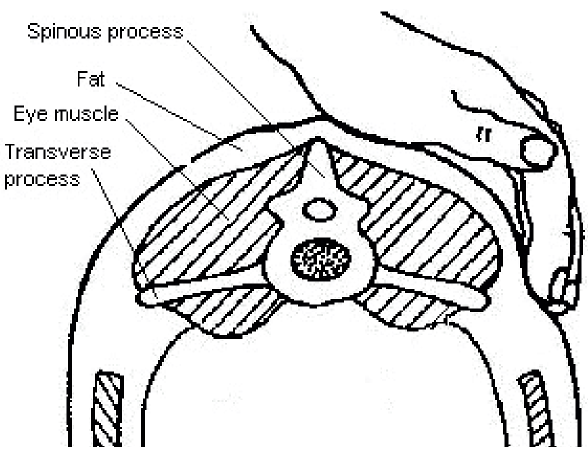


Figure 7. Sagittal section diagram of the spinous and transverse processes and how they are palpated to determine body condition.

3.1.1. General Considerations Regarding Pre-Mating Care

✓ Body condition (**Figure 7**).

Prolonged underfeeding can lead to poor oestrous cycle development in females and lower libido and/or sperm production in males as discussed in section 2.

The body condition parameter is critical in extensive farming models where there is not such close control of the animals and their feed. For

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example, in cattle it is recommended that the female should not be below 70% of her ideal live weight at the time of mating. In sheep and goats, body condition is assessed according to the musculature and fatness of the lumbar region between and below the spinous and transverse processes (**Figure 7**). The result is a scale from 0 to 5 according to whether they are very thin or obese.

The body condition score (nCC) (**Table 5**) of the herd or flock is calculated by assessing a significant number of animals, in any case not less than 10, and averaging the body condition of the animals assessed.

Table 5. Body condition scores in sheep

Body Condition Note	Parameters			
	Spinous process	Transverse process	Muscular area	General condition
0	Adhered skin	Adhered skin	No muscle is visible	Extremely thin
1	Prominent	Prominent. Fingers pass underneath	Thin, not greasy	Very thin
2	Undulation	Rounded. Finger passes with pressure	Moderate thickness	Thin
3	Rounded	Smooth and coated. It is perceptible to the touch	Full and convex area. Grease	Good condition
4	Only evident to the touch	The end is not appreciated	Area filled with thick coverage	Fat
5	It is not even noticeable to the touch	Not visible even with strong pressure	Dorsal line concave	Very fat

✓ Food.

In addition to covering at the right body condition, we must bear in mind that certain trace elements (iodine, selenium) as well as vitamin E are decisive in improving production rates. Rationing must be adapted to this productive phase, especially if we want to take advantage of the flushing effect.

3.1.2. Flushing

Two or three weeks before mating, the daily calorie ration should be increased (in the case of goats, a supplement of 150 g of oats is sufficient) as long as the animals come from a food restriction (nCC 2.25-2.75) and from anoestrus. This favours the activation of the oestrus cycle and an increase in the ovulation rate, thus improving the prolificacy of the flock.

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- ✓ Physical conditions.
- ✓ Temperature, humidity.

When temperature and humidity conditions are beyond the comfort or welfare margins of the animals, alterations in oestrus or milking may occur, which will affect mating. We must therefore ensure that the bedding is clean and dry, that there are no draughts, free access to housing that allows the animals to be sheltered from inclement weather (rain, wind, sun, etc.), etc. In very intensive animal systems (pigs and poultry, above all), cooling systems can be used, including air conditioning, sprinkler baths and forced ventilation. The correct functioning of these systems must be ensured, especially during reproductive cycles. Otherwise we could face these problems:

- ✓ Females:
- ✓ Silent oestrus.
- ✓ Increased embryonic mortality (abortions).
- ✓ Decreased fertilisation rate.
- ✓ Lower birth weight and increased perinatal mortality.
- ✓ Males:
- ✓ Decreased libido and sexual behaviour.
- ✓ Increased sperm abnormalities.
- ✓ Lower sperm motility and concentration.

3.2. Types of Mating

Depending on the degree of manipulation around mating (**Table 6**), we speak of natural mating when the male covers the female or artificial, when insemination is carried out by depositing semen previously extracted from the male in the vagina or uterus. They are the only methods allowed in organic production.

3.2.1. Natural Mating and Artificial Insemination

Natural mating can be **free** when the females susceptible to be covered by the males are not separated from the herd (extensive production systems) while sometimes we will make covering **batches** (typical in semi-extensive systems) concentrating the mating in a specific period in order to group calvings together and also to take advantage of the male effect already mentioned above and developed in the following table.

Controlled and directed mating implies an exhaustive detection of the female's oestrus, as we will be the ones to bring the male and female into contact to facilitate coitus or intercourse, even immobilising the female if necessary, as we will see in the following section. In this way the risks for the male are limited (falls, bruising or attack by the female, penile trauma).

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In **artificial insemination,** the correct environmental and feeding conditions of the males are fundamental.

As far as the female is concerned, both in artificial insemination and embryo implantation, we will have to provide both animals and facilities, as we will see in the following point.

Table 6. Advantages and disadvantages, as well as justification, of the different covering systems

Covering system	Pros	Cons	Justification
Artificial insemination	Male prolificacy	Labour and veterinary service costs	Intensive pig farming. Dairy cattle, sheep and goats. Equine.
Free riding	Cheaper	Lower reproductive rates.	Pigs, sheep, goats and extensive cattle.
Batch mounting	Cheap Improved reproductive indices.	Own labour force.	Pigs, sheep, goats and extensive cattle.
Directed mounting	Cheap Less risk in riding Genetic selection	Increased cost of own labour operation	Equine. Rabbits.

For the **male effect to** work in sheep and goats:

- ✓ The stallion shall be completely isolated from the herd (visually, aurally and olfactorily) for at least 30 days.
- ✓ Females should be in anoestrus (i.e., late spring).
- ✓ The ratio of males to females shall be 1/10-12. Full continuous physical contact between males and females is necessary.
- ✓ Experienced males in good body condition have more libido and are therefore more efficient.
- ✓ It does not work the same for all breeds, with native breeds being particularly sensitive.

3.3. Preparation of Males

The work with the males is very important, as they have a great impact on the productivity of the farm, more so than the females, since a male with problems can condition the matings of his flock, increase the interval between calvings, and decrease the number of calves/year, which means important economic losses, for this reason it is necessary to have a semen quality control and a sanitary control of the males.

3.3.1. Quality Control of Males

It is important to carry out a reproductive evaluation of each of the bulls, 1 or 2 months before the beginning of the breeding season, thus assessing that the fertility level is adequate.

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We must know their pathological state, evaluate the external reproductive apparatus (inspection and palpation) and internal (rectal palpation), the genital conditions (penis, foreskin, scrotum) and the non-genital conditions (good posture, eyesight, feeding).

After this evaluation, different diagnostic tests are performed to determine the bull's fertility potential. They also determine body condition (grade 5, on a scale from 1 to 9), testicular size, semen quality, libido, service capacity and mating ability.

Service capacity: is defined as the number of services that a bull performs in a pen, during a determined time.

After these tests are performed, the semen is extracted. There are two methods of semen extraction: by artificial vagina or by electroejaculator.

Once the semen is obtained, it is evaluated (spermiogram), it must be placed in a water bath, at a temperature of 37ºC. The first evaluation is macroscopic, to evaluate the volume directly, a bull older than 2 years should have an ejaculate of 4ml, which can vary between 2 and 12ml, the colour should be white or yellowish, the smell, if the bull is healthy it should have a smell like egg yolk, the appearance should be clean and homogeneous and density, the higher the density, the higher the sperm concentration.

The second evaluation is microscopic, and special materials are necessary to evaluate it, such as a microscope, here the mass motility (the capacity of movement of the spermatozoa), individual motility (% of motile cells), vitality, morphology of the spermatozoa, sperm concentration and pH are evaluated.

3.3.2. Sanitary Control of Males

The species where it is most commonly performed is in cattle. It is necessary to control diseases that can reduce the production of spermatozoa or render the males sterile, for which common bull diseases such as trichomonas and campylobacter must be diagnosed.

These diseases are sexually transmitted, the male is a carrier of the disease throughout his life without clinical signs, but in females it causes abortions and can cause sterility of the animal.

They are diagnosed by means of a preputial scraping, which consists of extracting a sample from the preputial cavity of the bulls to perform a culture and analyse the presence of the disease in the laboratory.

It is essential to do it every year before the bulls are put to the cows, with enough time so that in the case of a positive result, it can be treated (2 months before the bull is put to the cows).

To know our starting point, besides the work with the bulls, it is of crucial importance to make a diagnosis of the most frequent diseases in the area, especially in the agrosilvopastoral systems of Spain can have IBR (Infectious Bovine Rhinotracheitis) and BVD (Bovine Viral Diarrheal). This diagnosis should be carried out annually in non-vaccinated animals (heifers), in case they are positive for any of these diseases, it would indicate that we have an active pathology in our farm. Every farm should have a basic sanitary program.

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3.4. Preparation of Females

The preparation of the female for mating can start from the very moment we select the most suitable animals for reproduction from our replacement stock: mother's background, breasts and udder, conformation. Or when we incorporate females from another farm we must respect a period of quarantine according to the plan stipulated for this purpose, following perfectly all the aspects of the same in terms of:

- ✓ Cleaning and disinfection of facilities.
- ✓ Treatments (deworming, vaccinations).
- ✓ Food.
- ✓ And especially observation of any anomaly to be reported to the technical or veterinary manager of the holding.

In preparation for actual riding we must ensure that:

- ✓ Females have reached the minimum weight/age at first mating (nulliparous) as mentioned above.
- ✓ She has recovered her body condition after the previous birth and lactation (**Table 7**).
- ✓ They do not show any signs of disease, as these can be distinguished from normal signs of oestrus: abnormal secretions in the vulva, general appearance, mucous colour, etc.

Table 7. Recommended body condition score (BCS) for the different phases of the production cycle in Spanish ewes

Physiological state	BCS	Remarks
Cover	2,75-3,25	Effective flushing supplementation if BCS is between 2.25-2.75
Third month gestation	2,75-3,25	Eventually 2.50 in herds with very low prolificacy.
Childbirth	2,50-3,00	2.75-3.00 is recommended for the most prolific ewes.
1st month gestation	2,50-2,75	Not to exceed a mobilisation of 0.50 BCS points in 1 month.
1.5 months gestation	2,25-2,50	Not to exceed a mobilisation of 1 BCS point in 1.5 months.
Weaning (drying)	2,25	A rapid recovery of the body's condition is more efficient.

Females that are going to undergo directed or controlled mating as well as artificial insemination must be properly prepared in order to avoid health or traumatic risks to the male, when applicable, as well as to increase the probability of success:

- ✓ Absence of foreign bodies in the vulva or vagina.
- ✓ Cleaning of the perineal region (between anus and vulva).
- ✓ If possible, the sow should be restrained in a crate or similar, especially in the case of mares, or in an insemination pen in the case of sows.
- ✓ Immobilisation in lumbar position in sheep and goats for insemination. Normally manual restraint.

3.4.1. Safety

As we have seen, during this production phase, there will be close contact with the animals, so occupational risk prevention measures must be taken to the utmost (**Table 8)**.

- ✓ Personal protective equipment: safety boots (reinforced and non-slip), gloves, helmet in case of handling large livestock, antilumbalgia girdle.
- ✓ Free of objects and clean floors.
- ✓ Conveniently illuminated facilities, with chutes, gates, handling cage and pens in perfect state of use.
- ✓ When handling the animal, be aware of its flight and attack signals and anticipate its reaction. To do this, we should be aware of them as soon as we approach:
- ✓ Do not approach the animal from the front but from the side (left side at the level of the back in horses).
- ✓ Detect aggression in advance by talking to them gently and touching them.
- ✓ Isolated animals are more stressed and dangerous.
- ✓ Avoid sudden or abrupt noises and gestures.
- ✓ Consider whenever necessary the use of physical restraint systems.
- ✓ When restraining and leading the animal, the following must be taken into account:
- ✓ Act firmly and confidently.
- ✓ Avoid placing yourself or any part of your body between the animal and the walls or bars of the chute or rack.
- ✓ Make sure that the strand, head stall, etc. are in perfect condition.
- ✓ Do not attempt to restrain the animal in the event of a strong flight reflex.

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Table 8. Table of the most noteworthy behaviours and handling instructions to minimise the risk to operators

Species	Behaviour	Management
Equine	Let's look at the ears: • Vertical position: consent. • Backwards: displeasure. • Forward: attention.	• Approach from the left side at the level of the back. • Do not touch flanks. • Do not approach from behind.
Bovidae	Great variability according to breed. For example, dairy cattle more manageable. Very gregarious, beware of separation from the rest of the flock. Beware of sideways kicking.	They should always be considered dangerous. Use extreme caution with bulls. Especially if you do not know them. With the nose for large movements or by twisting the tail like a steering wheel it can be steered. Head restraints with ropes or a rack may be necessary.
Sheep	Very gregarious, therefore paying special attention to the flock as a whole. Flight as a form of defence. Sheep at close range tends to lunge.	Position yourself behind the animals whenever possible. Firm grip by several operators of the ram. Do not drive in front of the flock but alongside it.
Goat	Less gregarious.	More manageable in general than sheep.
Porcine	Attention to the flock. Isolate the animal in question by means of a lure and corner with a board or similar.	Rigid handle loop fastened on the muzzle behind the tusks. Do not enter housing with boars. Lead them in the aisles from behind.

3.5. Management in the Post-Mating Period

Stress should be avoided in the days after mating or artificial insemination to prevent embryonic absorption or non-implantation of the zygote. In the case of sows, it is estimated that for at least the first 35 days post-farrowing they should be kept quietly in their social group and without major handling. Feeding during this period does not differ greatly from the maintenance feeding of the animals. It is important to take into account the resting period between sows as mentioned in point 1 and the periodicity of the sows to increase the probability of success.

During the month following mating or artificial insemination avoid:

- ✓ Sanitary management of the collective (vaccinations, deworming, etc.) unless prescribed by a veterinarian. In any case, it should always be pointed out that the females are in the post-breeding period.
- ✓ Overcrowding.
- ✓ Long periods of food or water restriction.
- ✓ The use of dogs in livestock management.
- ✓ Shearing, hoof trimming or other maintenance management.

- ✓ Extreme environmental conditions in the facilities, especially in intensive farms: avoid. humidity (60-70%), never extreme temperatures and absence of irritating gases (ammonia) or particles in suspension, normally due to insufficient hygiene in the housing.

In the groups of females already covered, animals that have returned to heat due to an unsuccessful mating or an abnormality in early gestation should be monitored.

4. Gestation

We have seen in point 1, together with the knowledge of anatomy, how fertilisation takes place prior to the implantation of the zygote in the uterus. The first third of gestation is of great importance as it can cause problems such as non-implantation, resorption or miscarriage, as we have seen above, so we must be attentive to the indications for management.

Table 9. Gestation length interval in the main domestic species. Most common in brackets.

Animal	Gestation time (days)
Sheep	146-156 (150)
Goat	146-156 (150)
Cow	270-290 (280)
Mare	330-340 (336)
Donkey	360-365 (360)
Sow	113-120 (114)
Rabbit	30
Dog	60-63 (63)
Cat	56-60 (58)

4.1. Follow-Up and Care during Gestation

One of the first measures is the diagnosis of pregnancy, which will allow us to make decisions on the management of the female, towards parturition or if she has not become pregnant, to restart the cycle or to evict her if she has repeated the situation more than desired, therefore, we will have to keep a record of oestrus, matings and pregnancies. Another advantage of pregnancy diagnosis is to be able to anticipate twin births in monoparous species.

Clinical signs that indicate a possible pregnancy:

- ✓ Absence of oestrus. But be careful, e.g. 5% of mares and 10% of cows may be in oestrus during pregnancy.
- ✓ Modification of behaviour, e.g. increased docility.

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- ✓ Increase in abdominal volume, especially in the last third of gestation.
- ✓ Development of the mammary glands, also in the last stages of gestation.

Various methods of pregnancy diagnosis are available and any of them require some experimentation or recourse to veterinary services and are applied at around one month post-breeding:

- ✓ Indirect or laboratory diagnosis.
- ✓ Biological or immunological test (detection of progesterone and other pregnancy hormones).
- ✓ Histological. Vaginal mucosa sample (ewe and sow).
- ✓ Direct or clinical diagnosis
- ✓ Rectal palpation (cows, mares and donkeys).
- ✓ Abdominal palpation.
- ✓ Ultrasound.

Pregnant females are usually moved to a different enclosure where they will be fed according to their physiological state. We must warn farmers against any invasive management intervention (shearing, treatments, etc.) on pregnant animals, although they are less sensitive to stress than in the post-birth period (approximately one month).

4.2. Pre-Birth Management

In the last third of gestation it is advisable to change the feed, if this has not already been done, as the foetus begins to grow and the nutrient requirements of the dam will be greater. In any case, the body condition of the dam must be monitored, as excessive fattening can hinder lambing.

Figure 8. Farrowing pen in pigs

As we approach farrowing and depending on the species and management model it may be necessary to individualise the sows in breeding pens (**Figure 8**), stalls or stables. These enclosures should be clean and disinfected according to the plan stipulated for the production unit and have plenty of clean litter.

In the case of more extensive models in these agrosilvopastoral systems, it is not usual to individualising females, only in case of previous problems on the farm and is usually done at the last moment, when there is already evidence of calving. Watch for signs of parturition, as indicated below:

- ✓ Traditional system, along the length of a longitudinal building and with outdoor pens for the piglets' recreation. On the day of farrowing, the mother is left with the piglets. On subsequent days and until weaning, the sows only sleep with their offspring, leaving in the morning to go out into the fields and returning in the evening.
- ✓ Camping system, very widespread nowadays, especially in extensive or semi-extensive farms, as it can be considered cheap, at least in the short term. From the point of view of profitability, some authors question it, given the problems it poses, especially in terms of control and limitation of management practices.

Normally and in general terms, the Iberian sow does not present any special problems at farrowing. In addition, they have highly developed maternal qualities, which is why they are very rarely assisted.

In fact, in extensive livestock farming, and especially in the dehesa, when we intervene it is usually because something is wrong, as the ease of calving is very advisable when the animals are handled infrequently. In any case, let us see how a normal calving should develop in order to know when and how we should intervene.

5. Birthing

Parturition is the process that brings gestation to an end. During parturition, the female will undergo a series of physiological-anatomical changes that will make the birth of the offspring(s) possible. As mentioned in point 1, the internal reproductive organs of the female are located in the abdominal and pelvic cavities. In the latter, following the axis of the pelvic canal, the birth canal is formed when the female is about to give birth. In general, this axis is straight and therefore the exit of the foetus takes place without major problems, however in some species such as bovines where the pelvis is shaped like an "s" rotated 90º, complications can occur that may require assistance.

5.1 Monitoring and Care during Birthing

Behavioural changes: isolation from the herd, agitation, etc.

- ✓ Descent from the womb.
- ✓ Increased breast size and even milk production.
- ✓ Heavy breathing.
- ✓ Increase in body temperature.
- ✓ Ruminants and equids usually give birth standing or lying in lateral or sterno abdominal recumbency.
- ✓ The sow is lying on her side (lateral decubitus).

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In addition to the above signs, we must identify those signs of disease or disorders that can be reported to the veterinary services or to the person in charge of the production unit:

- ✓ Diarrhoeic stools.
- ✓ Mucus and mucous secretions.
- ✓ Post-partum prostration.
- ✓ Difficulty in standing.
- ✓ Abnormal milk secretion.

5.2. Stages in Birthing

- ✓ **Dilatation of the cervix**
- ✓ From the onset of contractions to the effacement of the cervix. The female is restless and there is a change in foetal attitude.
- ✓ **Expulsion of the foetus**
- ✓ First, the placenta and/or the legs of the neonate will emerge. The contractions of the uterine muscle (myometrium) increase and the abdominal pressure is produced. Finally, contractions of greater intensity and shorter interval cause expulsion of the neonate. The umbilical cord breaks by traction.
- ✓ **Expulsion of the placenta or placental debris**
- ✓ Placenta and placental debris must be expelled after delivery (**Figure 10**). If they last longer than usual, this can lead to what is known as retained placentae, which in the long term can cause uterine infection and subsequent infertility in the female. It is very important to note the time from expulsion of the foetus to complete expulsion of the placenta (**Table 10**). Animals that do not expel the placenta within the post-partum time frame specified in the adjacent table should be subjected to treatment under veterinary prescription (**Figure 9**).

Figure 9. Newly calved Bighorn cow. The expulsion of placenta can be seen.

Table 10. Typical time for placenta expulsion.

Species	Duration
Mare	30 minutes
Ruminants	12 hours
Sow	2 hours
Dog-Cat	8-10 hours

Figure 10. Sheep placenta normal appearance. Photo by the author. Fuente Teresa, Robledillo de la Vera, Cáceres, March 2013.

The **puerperium** is the period between the expulsion of the placenta and the resumption of the female's cyclical activity. During this period lactation begins and uterine involution takes place (**Table 11**).

Table 11. Time to complete uterine involution and expulsion of lochia in the main domestic species

Species	Uterine involution	Expulsion of lochia
Mare	30-45 days	<14 days
Cow	28 days	<14 day
Sheep-Goat	27 days	<10 days
Sow	28 days	<28 days
Dog-Cat	60 days	<21 days

The **lochia** are postpartum secretions composed of mucus, blood, placental debris and endometrial tissue. They are viscous in appearance and should be odourless, otherwise it may be due to uterine infection and veterinary services should be notified.

5.3. Postbirthing

Dystocic or abnormal delivery may be due to physiological alterations, malformations of the foetus, the mother or simply incompatibility between the two. For example, because the foetus is larger than the mother's birth canal.

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The first thing is to know the day of calving, especially in more intensive farms where pregnancy diagnosis is usually carried out. If the gestation period is too long, it is necessary to notify the veterinary services.

It is also important to record when the first symptoms of labour begin, water breaking, birth and finally expulsion of the second stage. Excessive delay in any of these phases can indicate that it is a dystocic labour and lead to the loss of the foetus, mother or uterine infection, damage to the neonate.

Table 12. Typical duration of calving by species

Species	Duration
Mare-Sheep-Goat	8-15 minutes
Cow	30 minutes-2 hours
Sow	2 hours (10-15 minutes/piglet)
Dog-Cat	2-3 hours (10-15 minutes/puppy)

In normal birth, the legs (usually the front legs) of the newborn will emerge first, followed by the head and the rest of the body. When there are several foetuses, look at the period between birth and birth (**Table 12**). In the case of monoparous species there may be up to one hour between birth and birth. The mother will lick the newborn and remove placental debris and stimulate it to stand up. This is the beginning by which the mother will recognise her offspring and in about 24 hours the neonate

will recognise its mother.

Occasionally a longer than usual birth can fatigue the mother who will require veterinary attention to complete the delivery.

The umbilical cord should never be cut as this can cause bleeding; the way to help would be to pull and break it by traction.

6. Milking

Lactation, the final phase of the mammalian reproductive cycle, is of paramount importance for the development of the neonate, providing it with the nutrients necessary for its development and initial immunity.

Colostrum is the first milk secretion. It contains a high concentration of immunoglobulins responsible for the first passive immunity of the mother towards the newborn, protecting it from infectious and parasitic diseases. It is produced 2-3 days postpartum and looks somewhat different from milk: creamier, yellowish and thicker.

The stages of lactation are:

- ✓ Rest.
- ✓ Milk secretion.

- ✓ Synthesis: lipids, proteins, carbohydrates, minerals, vitamins, enzymes, hormones and immunoglobulins (passive immunity for offspring).
- ✓ Flow.
- ✓ Excretion.
- ✓ Passive: by gravity.
- ✓ Ejection or let-down of milk by contractions of the myoepithelial cells of the breast plus the suckling of the newborn or milking.

The lactation period ends with the drying of the udder or teats. This may coincide with the weaning of the newborns or the end of the production cycle in dairy farms. This is a critical period in which we must pay extreme attention to the animals, especially their mammary glands.

6.1. Milking Timing

The duration of lactation will depend not only on the species or breed but also and above all on the production model of the farm in question. In these extensive meat production systems weaning takes place at a later age (**Table 13**).

Table 13. Minimum lactation length in organic livestock as a reference for extensive beef farms.

Species	Duration
Sheep-Goat	45 days
Cattle-Equine	90 days
Porcine	40 days

6.2. Primary Cares Avoiding Mastitis

During lactation the nutritional requirements of the dams change and increase, so it is necessary to monitor the correct rationing and the evolution of the body condition of the females during this period. It may also be necessary to monitor the weight gain (average daily weight gain) of the neonates, especially if we are involved in a selection programme for genetic improvement.

The appearance of the mammary glands should be monitored to ensure that there are no signs of disease, e.g., mastitis or mastitis (inflammation):

- ✓ Injuries.
- ✓ Abnormal discharge.
- ✓ Udder or breasts red, hard, hot, painful.
- ✓ Indurations in the parenchyma of the gland on deep palpation.
- ✓ General condition of the animal: decay, lack of appetite, agitation, etc.

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Lactation shall end with weaning of the neonates on meat or mixed meat-milk farms. In some special circumstances, such as certified organic farms, a minimum length of stay of the neonate with the lactating mother is required (**Table 13**). In any case, we must follow the protocol established for this purpose, as this is a critical moment in which mammary gland disorders such as the afore mentioned mastitis tend to appear.

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UNIT 8

NUTRITION

INTRODUCTION

Animals for slaughter are classified as monocavitary and polycavitary or ruminants according to their digestive apparatus and nutritional physiology. In the agrosilvopastoral systems we have a great representative of the monocavitarians: the Iberian pig; being nowadays the only species that has a fattening system based solely on the natural resources of these systems, especially the Dehesa: the Montanera.

On the other hand, ruminants, due to their peculiar physiology of digestion and use of structural carbohydrates (cellulose and hemicellulose), could become great transformers of pasture into excellent quality meat, and at a low cost, as has been seen in various experiments.

The nutritional needs of domestic animals depend, among other factors, on the time of production and type of management, so that the intervention of managers is essential for the correct use of livestock, maximising yields and without compromising animal health and welfare. In this sense, new methods for diagnosing nutritional needs and disorders, such as Obsalim, can be a great ally for farmers and managers in making decisions on rationing and monitoring correct grazing.

The rules for organic production in agroforestry systems are laid down in Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products. Feed for organic animals must be based on feed from the farm itself or from organic production units in the same region. Fattening practices shall always respect the normal feeding patterns of each species, these animals shall have permanent access to pasture, which must be organic.

1. Anatomy and Physiology of Nutrition

The digestive system of mammals is adapted and specialised to the specific diets of each animal. We are going to look at the general characteristics and peculiarities of pigs and ruminants (sheep, goats and cattle) as they are the main livestock species of the Dehesa and therefore the ones we have focused on so far. The former are defined as monocavitary as they have a monocompartmentalised stomach, while ruminants are polycavitary as they have a stomach divided into four compartments, as we will see later why. Horses and rabbits are also monocavitarians, but they are considered pseudoruminants or non-ruminant herbivores, as they have a digestive system with intermediate characteristics between the other two groups. Likewise, ruminants, at the moment of birth, have not fully developed their digestive apparatus and have digestive characteristics more similar to those of monocavitarians, which is why they are called preruminants.

1.1. Pigs

Strict monocavitarians such as pigs or poultry, unlike ruminants, are not able to digest the structural carbohydrates present in plants (cellulose, hemicellulose and pectin, the first two constituents of fibre). Therefore, in these animals, fibre consumption is limited because too much fibre causes digestive disturbances.

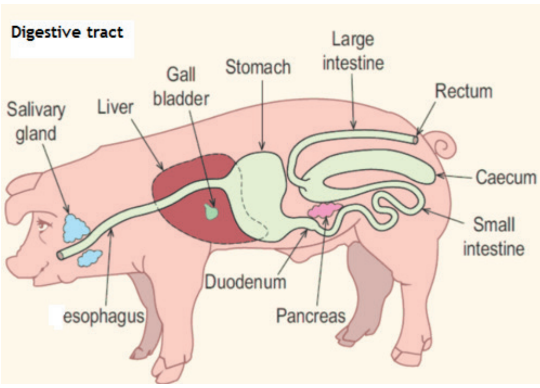

Figure 1. Diagram of the digestive tract of the pig

In the mouth (**Figure 1**) the digestive process begins with chewing and salivation with the incorporation of the first enzymes that begin the chemical digestion of carbohydrates. The bolus that will facilitate swallowing is formed. In the stomach, hydrochloric acid together with enzymes such as pepsin continue the digestion of proteins. In the stomach, the absorption of water begins and is completed in the large intestine. Through the pyloric sphincter, the chyme passes into the small intestine where it incorporates the bile salts from the liver necessary to form the micelles that will facilitate the digestion of fats; and the amylases (digestion of carbohydrates), trypsin (proteins) and lipase (fatty acids) produced by the pancreas. These enzymes, together with those responsible for the breakdown of carbohydrates into short-chain carbohydrates (maltose, sucrose, etc.), proteins into amino acids and triglycerides into dimonoglycerides, complete the chemical digestion, so that these immediate principles can be absorbed through the intestinal villi and pass into the bloodstream to be distributed throughout the organism.

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1.2. Ruminants

Cattle, sheep and goat are ruminants, i.e. they digest food in two stages: first they graze and then they ruminate, a process that consists of regurgitating the semi-digested material to continue digestion. This allows them to ingest large amounts of feed in a short time to allow digestion to proceed more slowly.

Figure 2. Apprehension of feed with the tongue in cattle

In fact, cows spend about eight hours a day ingesting their feed. They grasp the feed with their rough, agile tongue (**Figure 2**), and their lower incisors allow them to cut the grass against their dental pad; a slight backward movement of the head facilitates the cutting of the grass. A bovine gives about 40,000 jaw strokes per day (10,000 during feed intake and 30,000 during rumination).

In general, the process of digestion in enzymatic terms is similar to that seen for pigs, incorporating microbiological digestion (fermentation) which takes place in the rumen (or belly), followed by the reticulum, the omasum and finally the abomasum or rumen where most of the chemical digestion takes place.

Apart from the competitive advantage of this grazing regime, through rumination and the use of these four chambers, the stomach of ruminants is able to utilise the structural carbohydrates present in plants (cellulose, hemicellulose and pectin). They are therefore the herbivores best adapted to the consumption of plant matter, although not all of them in the same way.

Infants are called pre-ruminants as their digestion is not properly that of an adult ruminant. At the entrance of the rumen there is a fold of mucous membrane, the oesophageal canal, which allows milk and water to be swallowed directly from the oesophagus into the omasum. In this way, the liquids they ingest (especially breast milk) can evade the bacterial action of the rumen compartment and the movements of the reticulum. This channel or drip is formed by a reflex related to the suckling action. The earlier they start ingesting high quality vegetable matter (of higher digestibility, as we will see later), the earlier and better the development of the rest of the digestive tract will be. Key to generate a good physiology of nutrition and be a great transformer of pasture. Once weaning occurs, the importance of this structure is lost.

1.2.1. Digestion

The rumen is the largest chamber, representing about 80% of the total volume of the stomach (**Figure 3**). It is the first compartment of the stomach and a large storehouse after the first ingestion. Its wall is lined with ruminal papillae and contains several billion anaerobic microorganisms (bacteria, protozoa and fungi) that degrade structural carbohydrates such as cellulose contained in the animal feed to form volatile fatty acids which are absorbed by the stomach wall and are the main source of energy for the animal. The main fatty acids formed are acetic acid, propanoic acid and butyric acid, which account respectively for 60%, 20% and 15% of the volatile fatty acids digested during a typical forage-based feeding, although the proportions vary considerably depending on the composition of the ration. In addition, phytic acid (an important source of plant phosphorus) is degraded by microorganisms via phytic enzymes.

Rumen fermentation also provides ruminants with all the B vitamins, as well as vitamin K. Therefore, ruminants only require fat-soluble vitamins A, D and E in their diet.

It is also in the rumen that ruminants metabolise the nitrogenous matter ingested, which is transformed into ammonia by the microorganisms, which they then use to produce their own nitrogenous matter thanks to the energy provided by the carbohydrates present in the feed. The proteins synthesized by the microorganisms are assimilated in the form of amino acids when this bacterial flora is digested. Under normal conditions, the pH in the rumen can vary between 7 and 5.5 depending on the feed. The saliva excreted during rumination has a good buffering capacity and allows the pH to be maintained at these values.

1.2.2. Chemical Digestion

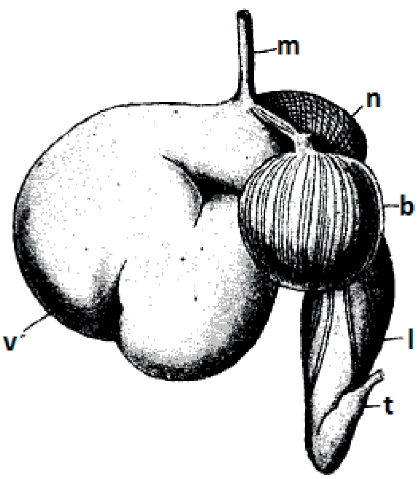

Figure 3. Diagram of the stomach of ruminants: m. oesophagus, v. rumen, n. reticulum, b. omasum, l. abomasum, t. beginning of the intestines

The function of the reticulum is to retain the feed particles and to move the digested feed into the omasum or into the rumen in the regurgitation of feed after rumination. Coarser particles are rejected into the belly before being chewed again in the rumination process. The finer particles can pass into the omasum.

The omasum is made up of thin sheets that are somewhat similar to the leaves of a book, hence the name "book" or "booklet." The book is an antechamber from which the food bolus passes into the curd and is responsible for absorbing the excess water contained in the food.

In the abomasum, gastric juices are secreted which subject the feed to enzymatic digestion of the feed particles and bacteria from the belly. In the abomasum, the ruminal microorganisms, which are largely made up of high-quality protein, are digested to amino acids and peptides and then absorbed in the small intestine. This process can

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convert protein that does not contain enough essential amino acids into complete protein, as well as transmuting non-protein nitrogen (NNP, see 1.2.5.) into useful proteins for the animal. Curdling is connected to the beginning of the intestine.

1.2.3. Guts

The digestive tract continues with the small intestine where digestion is completed and nutrient absorption continues. Finally, in the large intestine, the cecum is responsible for the fermentation of unabsorbed digestion products, the colon for the absorption of water and minerals, and the rectum receives the waste materials that remain after the whole process of food digestion, constituting the faeces that will be expelled through the anus.

1.2.4. Rumination

The walls of the rumen reticulum have a strong musculature. They carry out the ruminal movements, which effectively mix the contents and thus facilitate a continuous fermentation of the ingested feed. Important in this process is the formation of a floating fibrous mass in the middle and upper parts of the rumen, which stimulates ruminal movements.

The stimulation caused by a high amount of crude fibre close to the cardia causes an additional anti-peristaltic movement, whereby the animal regurgitates ruminal contents to the palate and promotes rumination.

The aim of rumination is to reduce the size of the fibrous particles to facilitate their passage to the rest of the gastrointestinal tract and outside, as a portion of the fibre is lignified, making it indigestible even for ruminal microorganisms.

1.2.5. Digestion of Proteins in Ruminants

Protein digestion by the digestive microbiota, which plays a unique role in ruminants, deserves perhaps a more detailed discussion. Non-protein nitrogen (NPN) refers to nitrogen compounds that can be converted into protein by some microorganisms, but are not directly digested by ruminants.

Many higher organisms can only obtain amino acids by absorbing them in the diet and then transforming some amino acids into other amino acids to form their own proteins. Ruminants can take them from microorganisms in their digestive system that do utilise these NPN compounds: ammonia, nitrites and nitrates, urea or uric acid. In fact, ruminants can be fed urea even with the remains of monocavitary excrement, as their microbiota "recycle" the nitrogen from the excrement.

There is a portion of the protein in the ration that does pass through to the abomasum where its digestion would be completed and it would then be absorbed. This dual pathway for obtaining amino acids makes protein digestibility calculations in ruminants more complex.

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1.2.6. Ruminants and Global Warming?

Today there is much controversy about the contribution of ruminants to the greenhouse effect. Let us explain why:

During this fermentative digestive process described above, not only volatile fatty acids are produced, which will then be absorbed for animal nutrition, but also greenhouse gases. It is estimated that around 6-7% of the energy consumed will be transformed into carbon dioxide and methane. Carbon dioxide is the most abundant greenhouse gas in absolute terms and methane has the highest greenhouse effect (21 times more than CO2). Methane production increases with increasing fibre in the diet. So the more concentrate (grain or compound feed) in the ration the less greenhouse gas production. Monocavitarians, especially poultry and then pigs, have the most adapted digestive system for utilizing cereals and grain protein in the diet, in contrast to ruminants. For example, bovines double or triple the conversion rate (kg fattened in relation to what is consumed) compared to monocavitarians and are therefore more inefficient in the digestion of concentrates.

However, an increase in vegetable oils in the ration or pasture has been shown to reduce methane production. In particular, a 1% increase in lipids decreases methane emission by 3.5%. Italian ryegrass (perhaps the most common grass in artificial pastures) has 2% of these oils. A good biodiverse pasture, such as in well-managed agroforestry systems, can contain up to 8% oils. In other words, such a pasture would reduce methane emissions by up to 20% compared to the same pasture with ryegrass alone.

On the other hand, the feeding of NPN to ruminants (not common in extensive livestock farming) increases the level of ammonium in the rumen and consequently more urea will be excreted, which increases the emission of nitrous oxide, another greenhouse gas, into the atmosphere. However, in this case, the responsibility for this lies more with conventional fattening, especially since it has been shown that tannins (very present in agrosilvopastoral systems such as Dehesa) are ammonium chelators, i.e. they reduce the risk of tympanism and also reduce the need to detoxify the ammonium which, instead of being excreted (urine), would pass through the digestive tract forming part of the faeces and increasing the nitrogen in the manure.

2. Animal Nutrition and Necessities

Ruminants require vegetable fibre in their ration. In feedlots a minimum of 10% in dry matter, but in organic feeding systems 60% fibre in dry matter. Therefore, both crude fibre (CF) and digestible fibre (DF) or actually assimilated fibre will be taken into account. Single-cavity pigs on the other hand need concentrates or high-calorie products such as acorns, as they do not have the capacity to digest structural carbohydrates like ruminants. This does not mean that they do not need fibre. Even we humans need fibre in our diet.

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There is an intake limit (higher in ruminants in relation to their live weight) and on the other hand, not all resources are equally palatable, i.e. they are not equally attractive to any animal, so we have to think about the different raw materials we use in the formulation of feed. And in our case, as shepherds, to what extent the animals will prefer one type of pasture to another.

The amount of grass consumed by cattle varies widely, but there are some general guidelines: 2 to 3 kg of dry matter (DM) per 100 kg live weight, so a 500 kg cow consuming 20% DM grass needs 50 to 75 kg of fresh grass. Grass consumption will be higher the more water the plant contains and according to the palatability of the forage: ryegrass is more appreciated by cattle than cocksfoot and fescue; clover more than alfalfa.

The requirements of animals for slaughter and the nutritional properties of the main resources and raw materials are periodically reviewed by different organizations such as the French Institute for Agricultural Research (INRA) or the Spanish Foundation for the Development of Nutrition (FEDNA). On the website of the latter you can find multiple tables with the composition of the main feed raw materials used in Spain.

In any case, the needs are usually based on studies carried out with animals kept under experimental conditions and normal development and health. For this reason, the needs in field conditions tend to be different, especially when working with indigenous breeds and systems as complex as those of ruminants, as we have seen. In fact, nutritional requirements are variable and depend on the level of consumption and daily gain, depending on factors such as genetics, sex, environment, health status, availability and absorption of nutrients by the animal, quality of raw materials, etc.

2.1. Energy

It can be measured as the heat produced by the food during combustion. The energy given off by raw materials in this way and which would therefore be ingested by animals is called Gross Energy (GE). Carbohydrates and fats are the body's primary energy resource, with cereals being the foodstuffs with the highest concentration of energy.

When this energy enters the body, part of it is eliminated through faecal matter and part is available to the body to be absorbed and called Digestible Energy (DE). In fact, the digestibility of raw materials is very important, because depending on their quality, animals will be able to make better use of them (**Figure 4**).

Part of the digestible energy is excreted in the urine and the resulting energy is Metabolizable Energy (ME). Finally, we must also consider the energy required in metabolic processes, the difference being the Net Energy (NE). The most commonly used in the above-mentioned tables is the metabolizable energy, as the net energy is not perfectly established, although it has been widely used since the 1980s.

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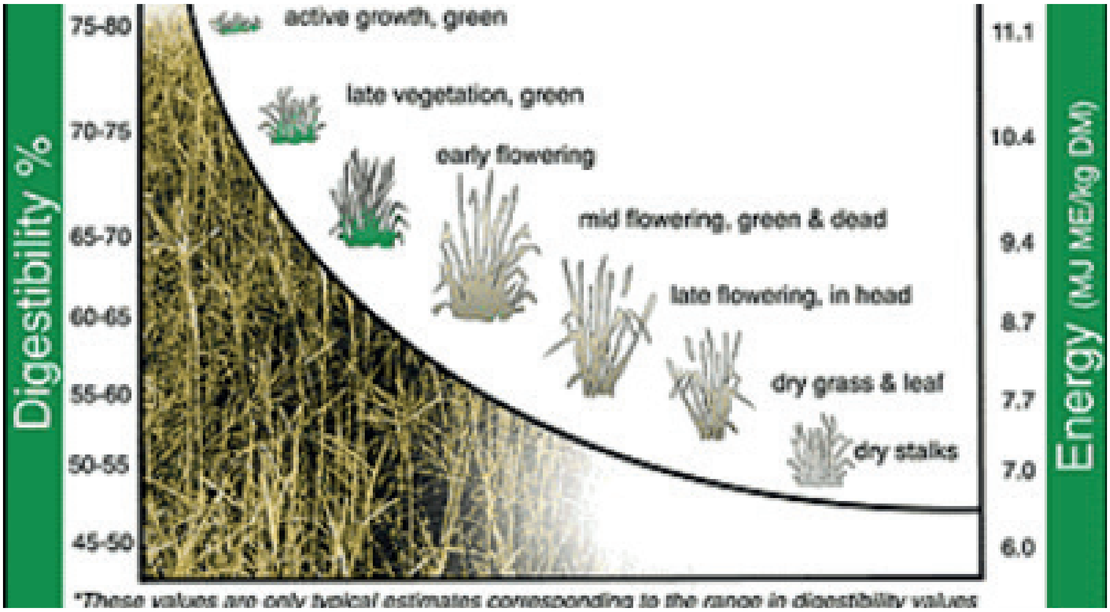
Figure 4. Digestibility in relation to metabolisable energy. As lignification increases, ME decreases



When net energy is used, the Forage Unit (FU) can be used, which is a reference unit established in the French system implemented by INRA. A fodder unit is the net energy contained in one kilogram of barley. The fodder unit milk (UFl) can be used, which is the net energy contained in one kilogram of barley used by a slow-growing or lactating animal and is equivalent to 1730 kcal. There is also the meat feed unit (FMUc), which is the net energy contained in one kilo of barley when used by a fattening or fast-growing animal and is equivalent to 1855 kcal.

Energy is expressed in Kilocalories or Joules of ME per kilo of feed, usually dry matter (DM) (Kcal or MJ/kg DM). Where 1 mega Joule=239 Kcal.

2.2. Proteins

Proteins, which are the main cellular constituent, are made up of a sequence of more than 20 amino acids in different combinations. Protein enters with the food and in the digestive tract is fragmented into amino acids which are absorbed and then form new protein molecules. Protein and amino acid requirements are proportionally higher in the young animal, gradually decreasing with increasing age. Females in late gestation and lactation also increase their protein requirements.

There are also essential amino acids (those that animals cannot synthesize by themselves and have to be in the diet) for the pig are Lysine, Threonine, Tryptophan, Methionine and Cystine. Therefore, the protein level of a raw material and the content of amino acids such as Lysine, which is the main amino acid for pigs, must be taken into account.

The biological value of a protein is given by its richness in essential amino acids. In general, the more the protein ingested resembles the animal's own protein, the higher the biological value. In fact, the protein with the highest biological value is that of animal origin.

Crude Protein (CP) is the protein that enters the food. Digestible Protein (DP) is the protein that passes into the bloodstream in the form of amino acids. The latter can also be referred to as total nitrogenous matter (TNM) or digestible nitrogenous matter (DNM). Other systems use Intestinal Digestible Protein Units (IDP), which is the amount of protein that is actually available to the animal in the intestine, after the rumen activity of protein utilization and synthesis, composed of the protein that passes through the rumen from the ration and that contributed by the rumen microbiota as we have seen above.

2.2.1. Rate Energy/Proteins

In general, animals adjust their intake to meet their energy needs, a fact that must be taken into account when formulating the ration so that the energy/protein ratio ensures adequate protein intake before the animal's calorie needs are met.

2.3. Minerals

Minerals have very diverse functions in the body: structural in many tissues, a wide variety of regulatory functions as co-factors for enzymes, for example, thus intervening in reproduction and growth.

They are classified into 2 groups: macro and micro minerals or elements. The macro minerals are Calcium, Phosphorus, Sodium, Chlorine and Potassium.

Calcium and phosphorus are essential for the development of the skeleton, but they are also of vital importance in the soft tissues. A deficiency of both or a poor ratio will lead to defective mineralization, reduced growth or reduced reproductive function. Phosphorus is found in cereals in the form of phytates, which are poorly utilized by pigs, but very well used by ruminants as we have seen above.

The source of chlorine and sodium is salt, and its supplementation is important for the normal development of animals in agroforestry systems.

The most common micro minerals are Zinc, Copper, Iron, Manganese, Iodine, Selenium, Chromium and Cobalt. The most common sources of minerals are inorganic and are introduced by plants in the food chain.

2.4. Vitamins

Vitamins are essential for metabolic function, tissue development, maintenance and growth, normal health status, etc. Some can be produced in the body, as we have seen for ruminants, but others must be incorporated via the diet.

Vitamins are classified as fat-soluble (A, D, E, K) and water-soluble (B vitamins, Nicotinic, Folic, Pantothenic, Biotin and Choline). The former are expressed in International Units and the latter in mg. In practice, the levels of vitamins provided by cereals are not taken into account; they are incorporated through vitamin-mineral complexes or vitamin-mineral correctors (CVM).

The stability of vitamins is affected by the following factors: heat, moisture, oxidation, temperature, light, pH, minerals and electrolytes. There are issues to be taken into account when mowing for subsequent silage or haymaking.

3. Other Physiological Needs: Water Requirements

Water supply in optimal quantity and quality is key to animal health and production success. Daily intake will depend on the type of animal, its physiological state, the type of feed, dry matter intake, as well as the temperature and humidity of the environment.

In terms of quality, we must guarantee the supply of water of good physicochemical and microbiological quality, supplied throughout the year in drinking troughs distributed throughout the agroforestry system.

The pH must be close to neutral, have low levels of total solids, be free of nitrites and nitrates, coliform germs, salmonella and other pathogens, contaminating residues of pesticides. It is advisable to carry out periodical controls to check the qualities.

A preventive measure against the spread of diseases is to limit the access of livestock to riverbanks, marshes, etc., avoiding sharing watering places with wildlife, the main source of tuberculosis, for example.

Water needs are covered by drinking water, feed water and metabolic water. The following tables show the differences in water consumption in ewes (**Table 1**) and cows (**Table 2**) in relation to environmental temperature and physiological state of the animals.

Table 1. Water consumption* (kg water per kg DM consumed) of sheep at different physiological stages at different temperatures

Sheep category	Temperature (Cº)			
	15	20	25	30
Growing lambs	2,0	2,6	3,0	4,0
Unpregnant or early pregnant ewes	2,0-2,5	2,6-3,3	3,0-3,8	4,0-5,0
Late pregnant ewes ✓ **With unique lambs** ✓ **With twins**	3,0-3,5 3,5-4,5	3,9-4,6 4,6-5,9	4,5-5,3 5,3-6,8	6,0-7,0 7,0-9,0
Lactating ewes ✓ **First month** ✓ **Subsequent month**	3,0-3,5 3,5-4,5	3,9-4,6 4,6-5,9	4,5-5,3 5,3-6,8	6,0-7,0 7,0-9,0

Table 2. Example of daily water requirements of cattle according to physiological state and ambient temperature

Temp.	Lactating cows (409 kg)	Pregnant cows (409 kg)	Growth (182/273 kg)		Termination (364/454 kg)	
4.4	43,1	25,4	15,1	20,1	27,6	32,9
10	47,7	27,3	16,3	22,0	29,9	36,6

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14.4	54,9	31,4	18,9	25,0	34,4	40,9
21,1	64,0	36,7	22	29,5	40,5	47,7
26,6	67,8		25,4	33,7	46,6	54,9
32,2	61,3		36	48,1	65,9	78,0

The dimensions, shape and location of water troughs must also be properly determined. Cows are gregarious animals, forming groups with one or more dominant animals that guide the movement and have priority in accessing and consuming water. Therefore, water troughs should be well dimensioned, preferably round in shape and not located in the corners of fences, so that the movement to them is from different places in the field and the animals have more space in their access to the water trough so as not to distort their social system and, ultimately, to reduce altercations.

4. Silvopastoral Systems and Animal Feeding

4.1. Definition of Silvopastoral Systems

Agrosilvopastoral systems are defined as the combination of forest stands and grazing of domestic animals, in a partnership that brings numerous zootechnical, forestry, economic and environmental benefits.

These systems are characterized by livestock husbandry practices that make use of natural resources and where trees are combined with natural or improved grasses, other forage crops and livestock. Livestock may consume the forage, produced in the systems, directly on site, or it may be cut and hauled and offered in feedlots (**Figure 5**).

Figure 5. Examples of Silvopastoral systems in Europe: Above left: Vineyards and sheep grazing in southern Portugal (Picture by João Palma). Above right: Silvopastoral system with Prunus avium in Galicia, Spain (Image by Michael den Herder). Bottom left: Sheep grazing in apple orchards in Northern Ireland. Below right: Dehesa, a combination of holm oak and cattle grazing in Southwest Spain

Among the advantages obtained by this type of systems and interactions are the following:

- ✓ Increased soil protection against erosion.
- ✓ Fire prevention through pastoral use.
- ✓ Maintaining biodiversity.
- ✓ Higher profitability per area by combining animal production and forestry.
- ✓ Higher levels of animal welfare by providing shelter in extensive systems, usually with less infrastructure.

The fodder resources offered by Silvopastoral systems to supply the nutritional needs of livestock according to their breed, aptitude or physiological state, mainly on the basis of a representative model that serves as inspiration and knowledge.

In Spain, the main Silvopastoral system is the Dehesa, which was created from the Mediterranean forest by human intervention for the use of livestock, forestry, also rain-fed agriculture. It is characterized by a more or less dispersed tree layer of the Quercus genus (holm oaks, cork oaks, oaks and gall oaks), generally with a cover of between 5 and 50%, a herbaceous layer of great diversity, and a shrub layer that may or may not be present.

4.2. Use of Forage Resources According to Type of Production System, Species and Livestock Breed

If we are managing an agrosilvopastoral system, we must know the nutritional needs of our herd, which will be determined, in part, by the type of livestock species and breed we have, as this will condition the grazing habits. Each species has its own peculiarities in relation to the use of the natural resources of different livestock species (**Table 3**).

Table 3. Environmental adaptation of goats, sheep and cows

Feature	Goat	Sheep	Cow
Grazing habit	Grazing	Grazing	Grazing
Selection capacity	Selective	Non-selective	Non-selective
Forage preference	70-80 % shrubs and other herbs 20-30 % grasses	70-80 % grasses 20-30 % shrubs and other herbs	70-80 % grasses 20-30 % shrubs and other herbs
Use of poor quality food	Best	Well	Worst
Digestion speed	Quick	Intermediate	Slow

In these agrosilvopastoral systems, beef, pig, sheep and goat (in this case also milk) production systems predominate, being less demanding nutritionally than dairy production. The indigenous breeds stand out among the herds, perfectly integrated into the system due to their hardiness and adaptation to the environment.

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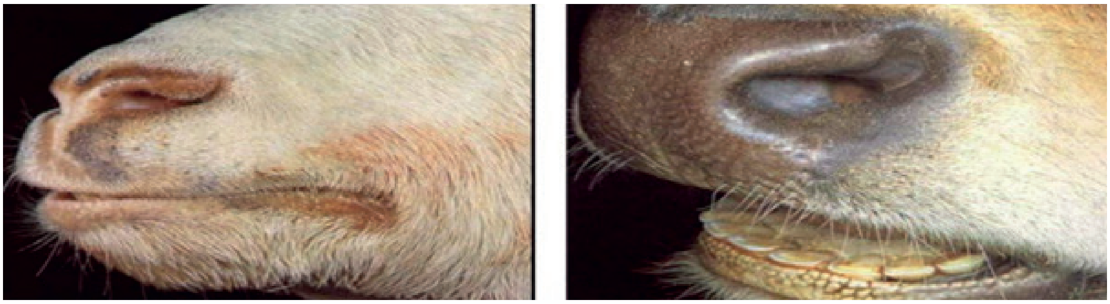
The anatomical-physiological differences in the digestive apparatus of livestock, seen above, will determine the use of grassland and forest resources. As a consequence, ruminants will have different grazing habits, from very selective (goats) to barely selective (cattle), as well as a preference for the consumption of different types of forage, from more lignified pastures such as shrubs by goats, to a preference for herbaceous pastures with low lignification such as cattle or sheep (**Figure 6**).

The goat, thanks to its mobile lips and a more developed rumen and papillae than other species such as the cow, has a "flower-to-flower" grazing habit with a greater selection capacity and preference for more lignified pastures. Between 70-80% of their diet is made up of shrub species and other grasses, and 20-30% of grasses. They are not prepared for high quality pastures, and their ingestion can cause diseases such as enterotoxaemia, especially when there are sudden changes in their diet. Their aptitude for forage use in areas of difficult access and more lignified pastures make these animals, especially native breeds, the most suitable for the performance of environmental services such as fire prevention.

Ewes, on the other hand, have a split lip, which allows them to practically tear up the grass and therefore make use of shorter pastures than cows. Also, although they are slower feeders than goats, they have a greater depth of bite (about 6 cm) and are slightly faster than cows. They have a more developed rumen than goats and therefore can afford slower chewing and rumination, eating every 4-7 hours. Sheep and cattle have a very similar grazing habit with a consumption of 70-80% grasses and 20-30% shrubs and other herbs.

Cows are the least selective of all ruminants and have the greatest depth of bite (about 10 cm), so extreme care must be taken to keep especially metallic objects in their pastures clean to avoid traumatic reticule pericarditis. The cows have large prehensile organs and graze with the help of the tongue and lateralization of the jaw. They leave about 5 cm average height behind which can mean on good quality pastures up to 1.5 t DM/ha. They should eat every 4-7 hours.

Figure 6. Lips of different livestock species due to different ecological niche. Left: Goats: thin and mobile lips. Right: Cattle: thick and immobile lips



In the traditional management of the Dehesa, the cows were grazed first, taking advantage of the highest pastures, and then the sheep or pigs were brought in during the autumn to take advantage of the acorns during the "Montanera" season. With few heads, pigs would be compatible with the rest of the small livestock, as would stables. Cows are also compatible with goats as they do not compete for resources. However, the sheep/goat combination is not compatible as their ecological niche overlaps somewhat and they share parasites.

4.3. Tree and Shrub Fodder Resources

Agrosilvopastoral systems are based on the use of forage resources offered by the ecosystem in a natural way, complemented where and when possible with annual forage crops, mainly cereals, legumes or a combination of both, and in some cases supplementation with concentrates.

Having a diversity of forage resources will make it easier to cope with the spatial and temporal variability of herbaceous production in Mediterranean ecosystems, as well as to provide a more balanced and nutritious diet for livestock.

Trees and shrubs offer a variety of fodder resources, from fruit, seeds and bark to twigs, consisting of leaves and fine twigs, which are mainly used during the lean season of the herbaceous stratum in autumn-winter. In contrast to the herbaceous layer, which is highly seasonal, woody species have green tissue all year round.

✓ The acorn.

In the context of the Dehesa in Mediterranean systems, acorns are used during the Montanera season, which runs from approximately the beginning of November to the end of February, for fattening acorn-fed Iberian pigs. Although its nutritional value is high, the average concentration of tannins present in the husk irritates the gastrointestinal mucous membranes and reduces the absorption of nutrients, thus reserving its use for the Iberian pigs, which have developed the ability to peel it, avoiding the consumption of the husk. However, it can be used by other animals. The presence of different species of the Quercus genus will allow us to extend the Montanera, due to the fact that they have different ripening periods.

In relation to average acorn production, we find very different ranges of variation (**Figure 7**), ranging from 300 to 600 kg/ha for Dehesa with cork oak groves and 250-600 kg/ha for holm oak groves.

Figure 7. Montanera of Iberian pigs in the Dehesa

As regards the nutritional quality of acorns, carbohydrates are the main nutritional component, being the main form of energy reserve. Its energy value is around 0,5 UF/kg, i.e. every 2 kg of acorns is equivalent to approximately 1 kg of barley. It is also a food rich in fats, characterized by its high oleic acid content. It is also high in macrominerals such as potassium, calcium, phosphorus and magnesium, microminerals such as iron and copper, and vitamin E. It is, however, considered a non-food. However, it is considered a non-protein food, due to its low protein content.

- ✓ The bark.

  Herbivores, especially ruminants, avidly consume the bark of many trees, which can be a very valuable food resource. In general, the dry matter contains about 3 % crude protein, 5 to 10 % fat and 40 to 55 % crude fibre.

- ✓ The ramon.

  Twigs, leaves and fine branches of trees and shrubs, have been an important fodder resource in agroforestry and pastoral ecosystems.

The forage value of many Spanish woody and shrubby grasses has been quantified (**Table 4**)

Table 4. Pastoral value of different types of Spanish trees

Trees	Forage value	Productivity (canopy > 70% - < 70%)		
		Pastoral value	FU/ha-year	LU/ha
Quercus ilex	Acceptable	12 - 20	540 - 900	0,24 - 0,40
Quercus pyrenaica	Acceptable	10 - 15	350 - 525	0,20 - 0,30
Quercus faginea	Acceptable	8 - 12	280 - 420	0,16 - 0,24
Fraxinus angustifolia	High	30 - 60	1.350 - 2.700	0,60 - 1,20
Ulmus minor	High	30 - 60	1.350 - 2.700	0,60 - 1,20
Juniperus thurifera	Acceptable	10 - 15	350 - 525	0,20 - 0,30
Pinus silvestris	Low	5 - 10	150 - 300	0.1 - 0.2
Pinus pinaster	Low	4 - 12	200 - 320	0,10 - 0,26
Pinus pinea	Low	4 - 10	180 - 450	0,10 - 0,20
Pinus halepensis	Low	5 - 13	200 - 520	0,10 - 0,26
Fagus sylvatica	Moderate	1 - 3	30 - 90	0,03 - 0,09
Alnus glutinosa	Moderate	3 - 6	90 - 180	0,06 - 0,12
Salix sp.	High	40 - 60	1.800 - 2.700	0,80 - 1,20
Populus sp.	High	5 - 30	225 - 1.800	0,10 - 0,80

In general, the foliage, understood as the set of leaves and branches, is an important source of proteins, minerals and vitamins. Its maximum nutritional values are reached in spring, decreasing as the season progresses. Also, leaves contain more protein and minerals than stems, and in the latter their nutritional value decreases as the diameter increases, contrary to what happens with fibre. In particular, the foliage of riparian trees (Populus, Ulmus, Acer, Robinia, etc.) has a high nutritional value, similar to that of medium quality hay. Poplars also stand out for their high nutritional value, reaching values of 50% digestible dry matter of which 15% is protein.

However, the toxicity to livestock of the foliage (and bark) of some trees and shrubs must be taken into account.

4.4. Herbaceous Forage Resources

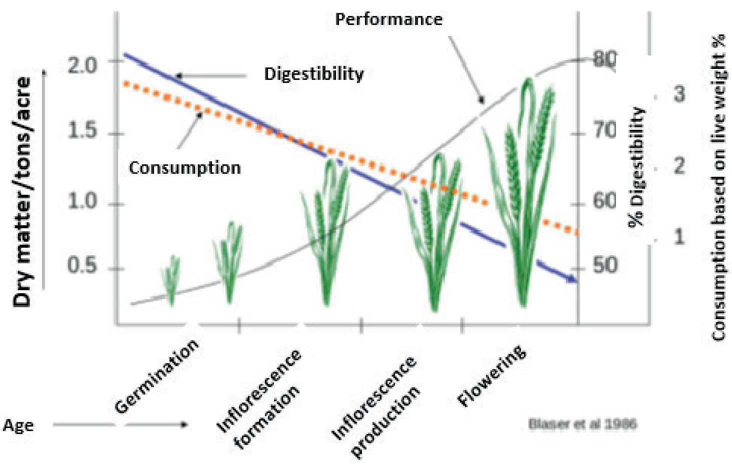
Natural grasses are the main feed resource for livestock in Silvopastoral systems. The main plant species of forage interest found in pastures or cultivated for livestock use belong to the grass and legume families.

Seasonal variations in grassland production can produce limited yields in critical periods, summer and winter, making it necessary to use fodder crops or extensive cereal crops or grain legumes in organic farming, which will produce fodder to feed livestock at any time of year, straw for bulk feed and stubble of great interest to ruminants in summer. However, these crops must be used in the most optimal areas (best soils, gentle slopes, etc.), minimizing the risk of erosion and managing them correctly.

As well as variations in terms of productivity, the quality of grassland also varies according to various factors such as grass composition and plant age, with a major deterioration following cropping, as will be discussed below.

As plants complete their life cycle, changes will occur that will vary their nutritional quality. As they age, the concentration of fibre will increase, thus decreasing their digestibility (**Figure 8**).

Figure 8. Variations in digestibility and yield in relation to plant age.



As the vegetative cycle of the plants progresses, dry matter and fibre increases and digestibility decreases, as well as other nutritional parameters such as protein and the concentration of minerals such as Ca, P, Mg, K. Therefore, we must seek a balance between the palatability of the pasture and its performance or productivity.

When the grass is too young, it will have a large amount of water (85% of its weight) and minerals (such as potassium, which has a laxative effect) and an excessive richness in nitrogen, which could cause pathologies in ruminants.

The ideal is to find the Optimum Resting Point (OSP), using them close to the beginning of flowering, approximately when 10 % of the grasses have flowered.

The nutritional quality of the grass will also be influenced by the species or botanical group to which it belongs. In relation to the differences between grasses and legumes, there are very few differences in digestible protein when they are young. However, as the plant ages, the difference becomes more pronounced and the decrease in grasses is much faster. The energy value decreases more slowly and there are few differences between the two families. However, grasses have more soluble carbohydrates than legumes, so in general they would provide more energy and would be more silageable.

In terms of minerals, legumes are richer in calcium, magnesium (especially clovers), copper and cobalt than grasses. On the other hand, grasses have a higher potassium and manganese content.

There are numerous factors that will modify the species composition of the pasture, including management factors (grazing management, fertilization); soil and climatic factors (soil and climate), as well as biological factors derived from inter- and intraspecific competition and the soil seed bank.

Livestock allow competition between species to be controlled. Thus, light grazing will allow grasses to dominate, while heavy grazing will increase the proportion of legumes, especially species with a prostrate growth habit.

4.5. Methods for Estimating the Quality and Productivity of Forage Resources

There are different methods that will allow us to estimate the quality and productivity of our forage resources. The choice of one or the other will depend on the economic resources and time we want to invest.

- ✓ Estimation of grass quality.

The quality of a pasture can be measured indirectly or directly. Indirectly, on the basis of the floristic composition (legumes, grasses and other grasses) or, even more so, on the basis of the grass/legume ratio. Since legumes provide twice as much crude protein, are richer in minerals, more palatable to livestock and also enrich the soil with nitrogen from which the grasses will benefit.

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This quality can also be measured directly, through bromatological methods, on the basis of crude protein (CP), neutral detergent fibre and acid detergent fibre (NDF and SDF) content, organic matter digestibility (OMD) and chemical mineralogical composition.

On the other hand, there are a number of simple indices that can help us to assess the quality of our grass:

- ✓ Greenness index and leaf/stem ratio: based on the colour of the plant or its greenness index and the ratio of leaves/stem (H/T), it is directly proportional to the quality.
- ✓ Pasture Pastoral Value (PV): based on botanical composition, assigning a value to each species.
- ✓ Estimation of pasture productivity.

There is a wide range of methods for estimating available grass production, with varying degrees of complexity. Broadly speaking, these methods can be divided into two main groups: direct methods and indirect methods (**Table 5**).

Table 5. Methods of calculating grass production

Direct methods o double sampling	Cutting plots
	Visual estimation and double sampling
	Categories and double sampling
Indirect methods	According to vegetation parameters (cover, height...)
	Normalised Vegetation Index
	Indices according to climatic parameters

Figure 9. Diagram of the steps to be followed to estimate kg DM/Ha with the direct cutting plot method

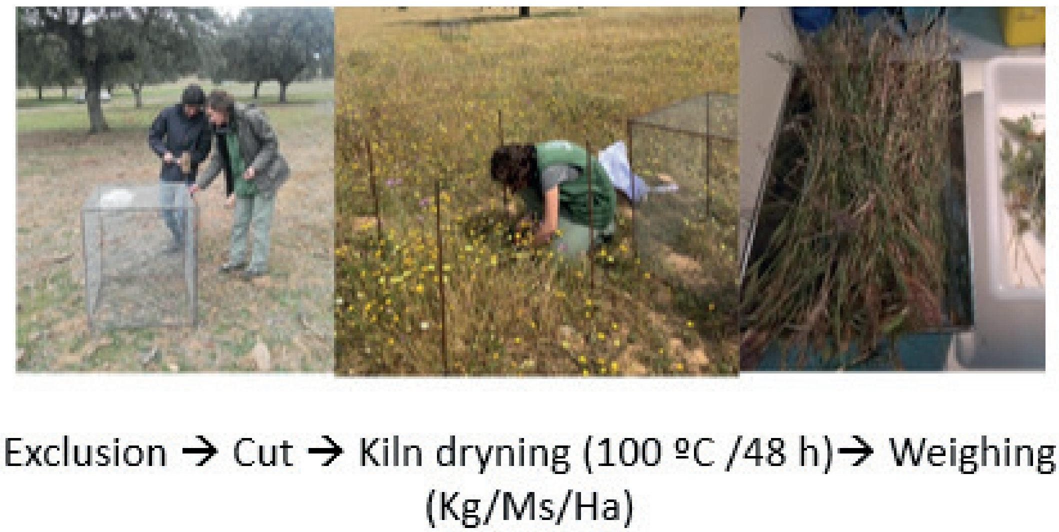
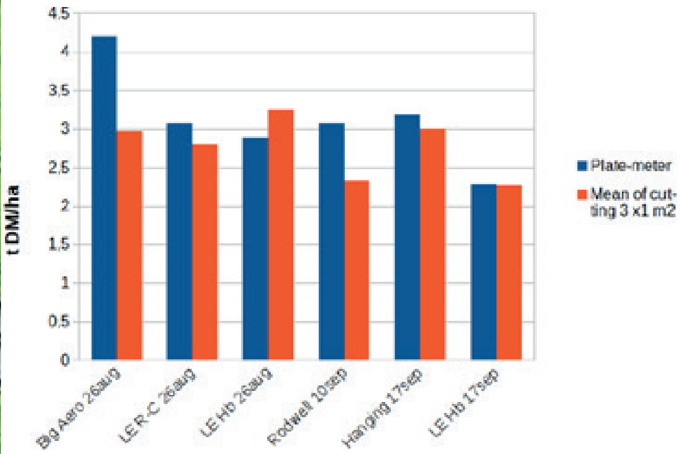


Figure 10. Indirect method according to vegetation parameters Left: Electronic measuring disc, an instrument that integrates grass height and density into a single measurement called "compressed forage height." Right: Comparison between dry matter calculated with the plate-meter method and the cut-plot method at Manor Farm.



5. Animal Feeding in Silvopastoralism

Due to production fluctuations, there will be a mismatch between the needs of the animals and the supply of fodder, so it will be necessary to supplement the animals with local and organic resources.

According to Regulation (EU) 2018/848 of the European Parliament and of the Council, at least 60 % of the feed will come from the farm itself or, if this is not possible or not available, will be produced in collaboration with other organic or in-conversion production units and operators using feed and feed materials from the same region. This percentage will be increased to 70 % from 1 January 2023, and at least 60 % of the dry matter in the daily ration shall consist of roughage, fresh or dried roughage or silage. This percentage may be reduced to 50 % for milk-producing animals for a maximum period of three months at the beginning of lactation.

As regards general nutritional requirements, animals shall be fed with in-conversion or organic feed that meets the nutritional needs of the animals at the various stages of their development; restricted feeding shall not be permitted in animal production unless justified on veterinary grounds.

Animals will have permanent access to pasture or roughage, growth promoters and synthetic amino acids will not be used, and feed materials derived from plants, algae, animals or yeasts shall be organic; non-organic feed materials, feed materials of microbial or mineral origin and non-organic feed additives and processing aids may only be used if they are authorized in accordance with Article 24 for use in organic production.

Article 24 specifies that the use of non-organic spices, herbs and molasses may only be used if they are necessary because no organic variant of these products is available; they have to be obtained or prepared without chemical solvents and their usage is limited to 1% of the feed ration of a given species, calculated yearly as a percentage of the dry matter of feed of agricultural origin.

On the other hand, as we have already studied in previous sections, forest fodder resources (fruits, seeds, twigs, bark) and fodder crops will allow us to increase the supply of grazing resources and to reduce supplementation.

Depending on the physiological state of the animals, there are two critical moments (**Table 6**) when adequate energy and protein supply must be ensured: late gestation and lactation.

In relation to grass fodder, in the Mediterranean context, the agricultural year can be divided according to the supplementation of livestock:

- ✓ Foreseeable variable supplementation period (15 June - 15 September): Herbage production is nil, cattle will graze stubble and senescent grass or will need to be supplied with part of the forage resources harvested.
- ✓ Period of necessary supplementation (15 September-15 October): In most years it will be necessary to supplement livestock with harvested forage resources.
- ✓ Unpredictable variable supplementation period (15 October-15 February): At this time it will be necessary to use the resources of browsing and a large part of the hay produced, as well as purchased straw and concentrate (cereal grain).
- ✓ Period of unnecessary supplementation (15 February-15 June): In this period, cattle normally have enough from grazing.

Table 6. Nutritional requirements according to physiological state

Physiological state	Season	Management	Needs		Forage		Supplement		Supplement
			UFL	PDI	Type	Kg	Type	Kg	€
Maintenance	Summer	Grazing	1.14	54	grass	0.852	barley	0.914	0.164
		Stall	0.71	56	straw	0.643	barley	0.364	0.123
					hay	1.134			0.140
Gestation	Spring	Grazing	1.07	107	grass	0.972	barley	0.249	0.045
	Summer	Grazing	1.36	107	grass	0.640	barley	0.913	0.204
		Stall	0.93	107	straw	0.594		0.763	0.169
Lactation weeks 4 to 6	Summer	Grazing	1.84	134	grass	1.036	barley	0.879	0.26
		Stall	1.41	134	straw	1.014	barley	0.518	0.265
Lactation weeks 1 to 3	Summer	Grazing	1.56	154	grass	1.01	barley	0.69	0.215
		Stall	1.13	154	straw	0.811	maize	0.856	0.211

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5.1. Types of Feeding

For supplementary feeding in these organic agrosilvopastoral systems it is necessary that both feed and supplements are organic. Concentrated feeds and preserved fodder are usually used, often grass hay (when it comes from the farm itself) or oat hay, as well as cereal-legume mixtures, especially oats and vetch, or alfalfa hay. It is also desirable for the animals to have a vitamin-mineral corrector added to the feed or available in the grazing area, as deficiencies in certain vitamins can lead to fertility losses.

The FEDNA (Spanish Foundation for the Development of Animal Nutrition) tables show the nutritional composition of most of the raw materials used in the composition of animal feed, as well as some silage and straw.

5.2. Animal Feeding under Grazing Conditions

In general, when grazing grain supplementation there are two important aspects that need to be considered:

- ✓ The effect of supplementation on forage digestion, mainly of fibre components.
- ✓ The important effect is the substitution of forage for the supplement.

Although related, there is not always a clear trend in the effect of one on the other. For example, in low quality forages, energy supplements generally depress fibre digestion to a greater extent than in high quality forages. However, the depression of forage intake by the use of supplements is less in low quality forages than in high quality forages.

When grain is offered, there is a partial depression of fibre digestion in the forage, which can undermine the benefit of adding a more digestible feed to the base forage.

Under low quality forage conditions, the digestive process is slower, because the complex structure of the fibre forces a sequence of events governed by different species of bacteria in the rumen. Any interference by the addition of grain (through a reduction in rumen pH, or because the fibre-digesting bacteria prefer starch), will have a depressive effect on the fibre digestion process.

Therefore, it is important that when supplementation is decided upon, high quality forage is achieved through grazing management. Before supplementing high quality forage, it is necessary to know a lot about pasture production and pasture management. These processes are closely linked and do not have a defined boundary.

5.3. Determination of the Necessary Feeding According to Physiological Needs

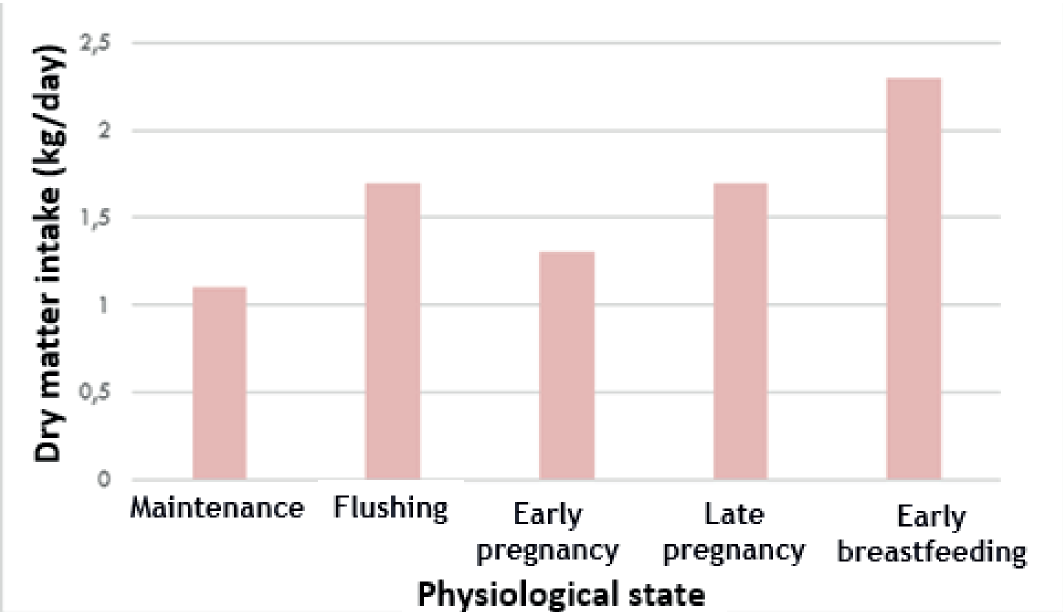
The nutritional requirements of the animals will also depend to a large extent on the physiological state (**Figure 11**):

- ✓ **Maintenance**: the animals have a body composition that remains constant. Generally, except in critical periods (late summer, very dry years, etc.), the animals are fed on pasture and do not require supplementation.

- ✓ **Gestation:** Two or three weeks before mating, supplementation (flushing) should be carried out, increasing the daily calorie ration (in the case of goats, a supplementation of 150 g of oats is sufficient) provided that the animals come from a food restriction (Body Condition Score 2.25-2.75) and from anestrus, i.e., from a period without oestrus. In this way, the activation of the oestrus cycle and an increase in the ovulation rate is favoured, thus improving the prolificacy of the herd. Special attention should also be paid at the end of management, as animals will have higher protein needs, especially in animals with more than one foetus.
- ✓ **Lactation:** During lactation the nutritional requirements of the mothers change, increasing the protein needs, so it will be necessary to monitor the supplementation and the evolution of the body condition of the females. In the case of dairy farms, rationing will be based on milk production.

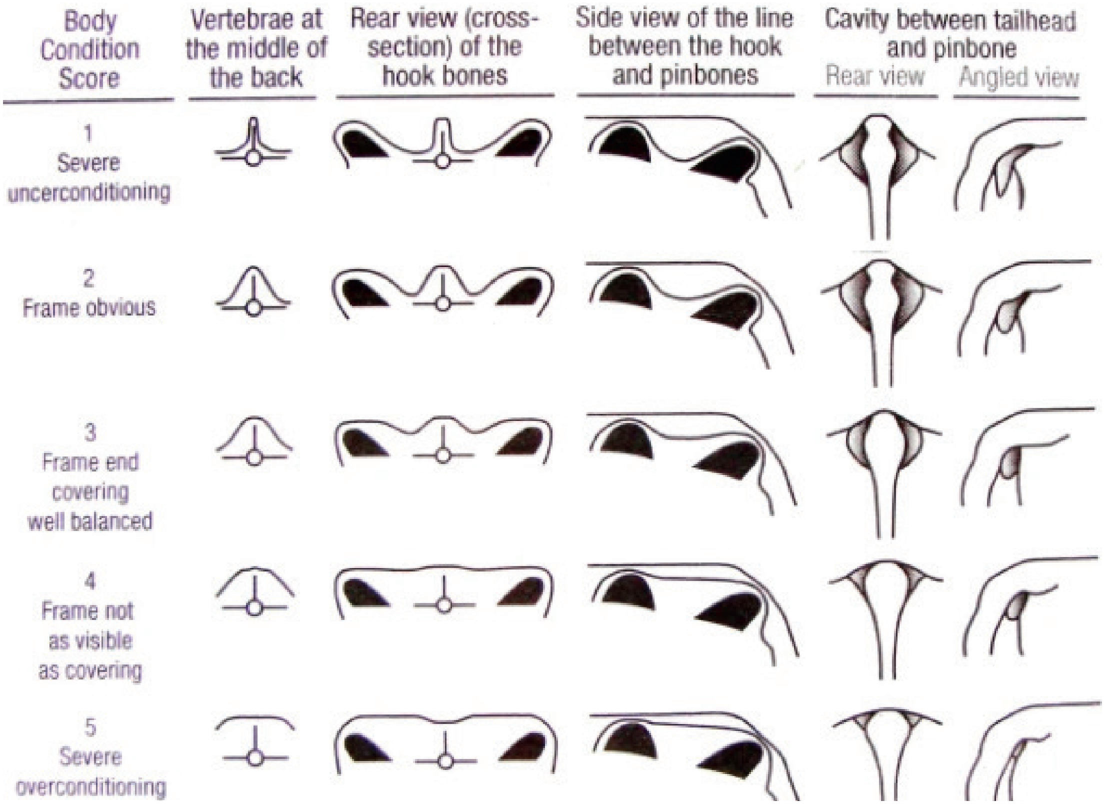
Males have 10-15% higher maintenance requirements than females, and it is important to keep them in good body condition, especially in preparation for mating, which can be achieved by flushing for 4-6 weeks prior to mating.

Figure 11. Dry matter intake (kg/day) in relation to physiological state



The reference index that measures the fat reserve status of the animal is the body condition (**Figure 12**). The measurement is made by standing behind the animal and palpating the lumbar region at the level of the kidneys. The degree of fat cover of the transverse processes of these vertebrae is determined by touch, as well as the depth of the loin muscles and their fat cover.

Figure 12. Degrees of body condition



Therefore, how to supplement (what amount of protein or energy) will depend on the time of the production cycle (**Table 7**), the type of pasture available and the body condition of the animals.

Table 7. Body condition score (BCS) in relation to the different physiological states of Spanish ewes

Physiological state	BCS	Remarks
Cover	3,0-3,5	Effective Flushing if nCC is between 2,24 and 2,75
3rd month of gestation	3.0-3,5	possibly lower in herds with low prolificacy
Childbirth	3,5	Obliged in prolific ewes
42 days lactation	2,5-3,5	Never go below 2 Not to drop more than 1 point in 42 days
Weaning	2,0-2,5	Do not exceed 8 weeks of lactation on energy underfeeding.

6. Impact of Diet in Carcass Quality

The most outstanding product of the agrosilvopastoral systems in Spain is the Iberian pig in Montanera, the result of a breed that is perfectly integrated into the agro-ecosystem to take advantage of resources that allow it to put on more than 40 kg in just a few months of fattening, it enters Montanera with 115-120 kg and has an average daily gain of 750 gr.

At present, pigs are the only livestock species kept on pasture/natural resources in these Agrosilvopastoral systems. In sheep until the 19th century it was common to keep a flock of rams up to a third (or even half) of the livestock for sale for meat. In cattle, their presence in these systems as slaughter cattle was very limited, until the last century, the oxen were finished at pasture and so were the erales (animals of 2 years of age). Kids have never been fattened as in other species, it was usual to slaughter them as soon as possible, the main resource being milk.

6.1. Grain Feed

Why has the disappearance of the "Montanera" meat disappeared, except for pigs? Is the consumer's preference in Mediterranean Europe for pink meat and white fats, from animals that are barely weaned or appear to be so, the only cause?

In the development of the animals, first bone is created, then muscle and finally, at maturity, fat. The development curve of our native breeds, which are not precocious, reaches the ideal proportion of fat at a later age than the more meaty breeds of Northern Europe. If we want carcasses with these characteristics, we have to fatten with concentrates (low carotene content, responsible for the red/yellow colour in muscle/fat) for a long period of time to reach standard live weights.

This means cost overruns, increased risk, inefficiency and environmental impact. Fattening ruminants on concentrates is clearly madness. Such high conversion rates as we have seen above mean throwing away valuable energy in a world soon to reach 9 billion people. Especially when we know that the same animal could be using an otherwise unproductive resource such as grass.

The consumer wants this meat. Wrong. The consumer here wants veal with these conditions, but he also wants beef, he also eats processed meat. But meat is not only eaten in Spain or in the Mediterranean area. In Northern European countries, in the USA, i.e., in the biggest meat markets in the world, red/yellow meat is consumed. Grass feed beef and oxen, as we will see in the next point.

6.2. Grass Feed

According to a work to be published between the Instituto Tecnológico-Alimentario de Castilla y León (ITACYL), CICYTEX, UEX in the framework of the innovation project

GoDEHESA, lambs finished at pasture showed a significant difference in the proportions of different fatty acids, including: lower proportion of C18:1 and higher proportion of C18:1n7, C18:3n3, C18:2n7 (CLA, 80% more of conjugated linoleic acid), C20:0, C22:6n3 in relation to the group of lambs finished on feedlot (30 days). In other words, the lambs from the pasture group showed a lower proportion of monounsaturated fatty acids, tended to have a higher proportion of polyunsaturated and n3 fatty acids and therefore a lower n6/n3 ratio (3.3 vs. 5.8). Therefore, meats from the pasture-grazed flock are healthier (they comply with the WHO's 1:4 omega ratio rule, for example), equally healthy (no pathogens), with less fat cover and a similar conformation to the conventional ones (same butcher yields). Redder meats and with yellower fat (which, of course, reduces the market in the Mediterranean context).

Previous studies carried out at La Orden-Valdesequera have once again demonstrated that the production system is a determining factor in the physical and chemical composition of the meat of Iberian pigs.

Thus, the meat from Montanera animals had a higher water retention capacity (WRC) and lower water losses due to defrosting than that from Intensive production; the Recebo animals showed an intermediate behavior, overall. Textural properties due to myofibrillar structure (Texture Profile Analysis (TPA) 20%) showed that meat from animals in Intensive and commercial diets had less desirable characteristics in terms of hardness, gumminess, cohesiveness, chewiness and recoverability. However, the production system had no significant effect on collagen structure (TPA 80%). The Warner-Bratzler (W-B) test showed that meat from intensive production showed higher shear strength than meat from extensive production.

The production system did not affect the pH values (24h), but it did affect the colour of the meat, with the meat from Montanera animals being brighter (L*), redder (a*) and more intense in colour (C*) than that from Recebo and intensive rearing.

The nutritional composition changed very little between the different production systems, but the antioxidant content (a, g-tocopherol and total phenols), antioxidant activity and unsaturated fatty acid (UFA) content, especially C18:1, C18:3 and C20:1, was higher in meat from Montanera animals than from intensive and Recebo.

The two muscles studied (LD and SV) showed differences in some parameters of texture and physicochemical composition. Thus, SV had higher values of pH(24h), intramuscular fat (IMF), red index (a*) and myoglobin content than LD, but lower water losses due to defrosting and cooking, therefore, lower hardness, gumminess, chewiness and lightness (L*).

In terms of antioxidant composition, SV showed higher values of a-tocopherol, total phenols, but also higher oxidative status than LD. However, LD showed higher amounts of MUFA than SV, which had a higher proportion of PUFA. No differences were found in saturated fatty acids (SFA).

In cattle, there is also nutritional, economic and zootechnical evidence on the advantages of fattening calves on grass, forage or unifeed diets. In a study carried out at the Centro de Investigación y Tecnología Agroalimentaria de Aragón, four experiments have been tested in this respect.

In the PRADECO and PRADERA lots, the animals used organic and conventional Pyrenean pastures, respectively, with two lots in each one supplemented with 2.5 kg/d of feed or cereal in the first case and with feed limited to 3 kg/d or ad libitum in the second.

PRADALF with two batches of alfalfa grazing supplemented with 2 kg/d of barley in one case or finishing on feed and straw in the other.

PRADECEB with two batches of castrated calves, fed in winter on dry unifeed (60:40) and in spring on mountain pasture supplemented with maize, in one case or finished on dry unifeed in the second.

Finally, in the Lleida Pyrenees, a group of organic calves fattened on alfalfa hay and organic feed ad libitum was studied. In most of the batches there was a control group of animals fed with feed and straw with the classical 90:10 ratio.

The results show a 10% reduction in average daily gain in the grazed flock (1.1 kg/d) compared to the conventional fattening. The unifeed finishers had a gain equivalent to that of the control group. As expected, the fat of the pasture-finished animals was more yellow. However, differences in muscle were attributable to breed or sex rather than finishing ration. Intramuscular fat in the unifeed animals was equivalent to that of the conventional animals at 15 months after slaughter.

In terms of meat quality, forage-fed animals had more linoleic acid than conventionally fattened animals, making them healthier meats. Finishing costs attributable to feed were 1.3 euros for feed and straw, 1 € for grassland and 0.6 €/kg fed on the unifeed diet.

Recent research by the Institute of Food Technology in Chicago has shown that meat from finished lambs that do not receive grain in their diet is richer in polyunsaturated fatty acids and also sometimes more antioxidants, iron, zinc and of course high biological value protein.

The relevance of animal fats for health is well known. High values of polyunsaturated to saturated fatty acids, as well as a ratio of omega-6 to omega-3 fatty acids (n-6/n-3) of less than 4 would be beneficial for health according to FAO and WHO (1994). Of the 12 feeding combinations in cattle (grassland, alfalfa, unifeed and conventional, depending on the amount of feed supplemented, certified organic or not) only animals finished on alfalfa without testing grain had an n-6/n-3 ratio below 4. Finally, conjugated linoleic acid (important for the prevention of some types of cancer) showed higher values in the meats of animals finished on forage than those fattened on feed and straw (conventional model).

7. Empirical Diagnosis of Nutrition Needs and Eating Disorders: Obsalim®

Through knowledge of body condition (**Figure 12**) we can make decisions on supplementation to improve the reproductive indices of the livestock farm. Another simple and inexpensive method to diagnose nutritional needs and disorders in ruminants: Obsalim ®.

The Obsalim diagnosis has been developed by the French Veterinarian Dr. **Bruno Giboudeau**[9] over 25 years of observation, practice and feedback with the farmers who use it. It is based on fifty or so symptoms which, when properly interpreted, allow us to find out what is wrong with the ration or feeding of our herd and to apply the appropriate measures to correct it.

The method started to be used in organic farming but quickly spread to conventional dairy farmers first and then to all types of dairy farmers. According to Edward De Beukelaer (Sept. 2013, personal communication) more than 300 farmers currently use it in France and about thirty in the UK, where he is the representative. It is also used in North America. It arrived in Spain in 2013 through a course in Galicia in March organized by XAN agroganadera and the online course "Good practices in extensive livestock farming" that we organized for Unión de Ganaderos 2008. In 2015 students of the course "Good sanitary practices in extensive livestock farming" (from the General Directorate of Rural Development) put it into practice in two dairy cattle farms in Carcaboso (Cáceres) with excellent results. Its translation into Spanish has recently been completed to make this innovation more accessible.

Figure 13. Moments of practice of the Obsalim method in two dairy cattle farms in Carcaboso, 2015

a) Criteria

Where the fermentable rate refers to the resource available for microbial activity and the overall rate refers to the resource actually available to the animal.

9 **Bruno Giboudeau's photo was taken https://www.obsalim.com/de/vorstellung-methode.htm.**

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Energy:

fE. Fermentable energy.

gE. Global energy.

Protein and nitrogen:

fP. Fermentable protein.

gP. Global protein.

Fibres.

fF. Fermentable fibres.

sF. Non-fermentable structural fibres that promote rumination. They stimulate saliva production and thus help to buffer the rumen pH.

rS. Rumen stability.

It indicates the stability of the rumen, it is the basis of the whole system.

The tools used are sets of cards for each species: sheep, goats and cattle (51 cards each); with descriptive images and the different values of the indices (**Figure 14**). There is also a practical interpretation guide, a computer program and a book: "The cows tell us about their nutrition" which serves as a complement to the method.

Figure 14. Sequence of steps to follow: herd trending, symptom observation, charting and rationing during Edward De Beukelaer's show. The Costworths, United Kingdom. 28 September 2013

b) Four steps

1. Trend in the herd

By systematic observation of a representative sample of animals chosen at random: coat, droppings, eye, ears, muzzle.

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2. Midline (Figure 15)

Dirt, perspiration residues, bedding deposits.

Figure 15. Midline

3. Rumen stability

The area that indicates the pH status of the rumen is on the back of the animal. The appearance of the faeces is also important at this level.

4. Establish the Composition of the Ration

Once we have chosen the cards with the symptoms of the flock (at least symptoms from three different areas), we have to look at the one with the highest and the lowest value. Then add up the indices of each criterion. As a result we will have a numerical formula that with the help of the guide or the computer program we will know how to interpret and apply the appropriate measures.

On the occasion of the onsite courses for livestock farmers, we will have the opportunity to work with the charts and the guide in the English version. More information on the website http://www.obsalim.com/.

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UNIT 9:

FARM MANAGEMENT

INTRODUCTION

Organic farming is a "whole system" approach to farming and food production. It produces high quality food using methods that are beneficial to wildlife, the planet and people, which no other defined food production system achieves. High standards in animal health, the environment and animal welfare are intrinsic to producing high quality organic products. It aims to work within natural cycles across soil, animals and plants ensuring that the biological activity of the soils is maintained as well as achieving long term fertility. Organic systems aim to reduce the reliance on external inputs, promote self-sufficiency alongside working in balance with the environment.

Within the EU, organic food and farming systems are legally defined by the EU. Each member state's certifying body then interprets these regulations for national use.

This chapter will discuss organic farm management, highlighting organic specifications and requirements for various livestock production systems. In addition, it aims to highlight how these organic systems differ from conventional systems.

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1. Typical Production Systems

What makes a farm organic?

The fundamental principles of organic farming are built on the mantra that healthy soils result in healthy crops, healthy livestock, healthy people and a healthy planet. With regards to livestock, organic standards ensure that animals are treated ethically, allowing management practices which meet their physiological and behavioural needs.

Some of the major differences to conventional farming are:

- ✓ Organic farmers cannot use chemical pesticides or fertilisers, except for a very limited number of approved products/substances and only in specific circumstances. There are around 20 such permitted chemicals that can be used in organic systems (with specific approval), compared with over 400 pesticides that can be used in conventional systems.
- ✓ Organic farming uses preventative husbandry methods and a limited number of approved materials to control disease, pests and weeds.
- ✓ Organic farming uses management methods such as crop rotation and other husbandry methods to actively build soil fertility.

All of these methods aim to deliver and sustain soils, ecosystems, people and animals.

How do farmers go about converting their conventional system to an organic farming system?

1.1. Converting Livestock to Organic from Non-Organic Systems

Conversion periods will be varying depending on the livestock species being converted to organic. No products can be legally sold as organic until the conversion period has been completed across the whole farm, and the holding is organically certified by a nationally approved body.

For all livestock species, animals can be termed organic animals if they were born on an organic holding and raised according to organic standards for the duration of their lives. Only animals which meet these requirements, are allowed to be sold under an organic label. There are some exceptions to this rule. For example, for breeding purposes, livestock from other holdings are allowed onto a holding, providing they meet certain criteria (see section 1.1.1. Sourcing Livestock for specific details).

Ideally animals will come from another organic flock or herd but animals from farms 'in-conversion' to organic or deemed non-organic are, with official approval, acceptable when organic animals are not available (for example in sufficient number, location etc.). Mating of organic animals may also occur on in-conversion land. Records for all animal movements must be kept. See Chapter Food Safety, section 3.1.3. Livestock Production for more specific details on record keeping.

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When non-organic animals have been brought onto the holding (for legitimate reasons described above) and the farmer wishes to sell their products as organic, there are minimum time periods, depending on species which the animals must be kept on the holding before they can achieve organic status.

The different time periods are as follows:

- ✓ Cattle: 12 months for any cattle being sold for meat and in any case they must have spent at least 3/4 of their lives on the holding. Their mothers must have been certified as organic, 12 weeks before calving.
- ✓ Pigs: 6 months on the holding.
- ✓ Sheep: 6 months for milk production. Managed to organic standards from mating for meat production.
- ✓ Cows: 6 months for milk production.
- ✓ Goats: 6 months for milk production.
- ✓ Gilts or sows: Managed to organic standards from mating.
- ✓ Poultry: 6 weeks for egg production.
- ✓ Poultry: 10 weeks for meat production in slow-growing systems but they must have been brought in before they are 3 days old. Fast growing strains have different conversion criteria.

Where non-organic animals are present on the holding at the start of conversion, farmers may convert all animals, land and pasture used for feed for animal grazing at the same time. A minimum period of 24 months is required to allow products to be sold as organic. There are specifications on the animals' diet whilst on the holding, in order to meet organic requirements. For example, the animals must be fed with at least 51% of their diet produced from the holding to maintain organic status. Other criteria apply to diet during conversion and after conversion. For further information, see section 1.2.1. Feeding and Nutrition and 1.3. Species Specific Organic Production Systems.

1.1.1. Sourcing Livestock

In organic systems (and those in conversion) all animals must be bred on the holding to maintain organic status. However, for breeding purposes and to avoid any inbreeding, this is not always possible, and animals from other farms may be brought in, preferably from other organic holdings. If this is not possible, and with specific permission, animals that are in conversion or those that are non-organic can be used. Discussions with the certification officer must take place before the non-organic animals are purchased and brought onto a holding. Records must be kept (see Chapter Food Safety, section 3.1. Record Keeping for more details).

When selecting livestock for organic systems, native breeds or strains are favoured in organic systems over non-native breeds. Where possible, animals should:

- ✓ Be suitable to thrive in the location of holding e.g. animals adapted for harsh, mountainous conditions in holdings located high above sea level.
- ✓ Have resistance to disease and show appropriate vitality. Some breeds are predisposed to health issues such as porcine stress syndrome, difficult births requiring caesarean sections, abortion, sudden death syndrome etc. These breeds should be avoided in organic systems.
- ✓ Not need any mutilation. This will be possible where indigenous breeds and/or those adapted to local climate are selected.

Organic standards require that livestock which are obtained from non-organic sources, may need special measures (e.g. screening tests) or specific quarantine periods decided by the local authorities. Therefore, farmers should check with their local organic certification body before bringing animals onto their holding, as this could compromise their organic status.

1.1.2. Establishing a Flock or Herd

When establishing a new herd or flock when a holding is "in conversion", animals may be sourced from any holding, regardless of organic status. Once the land becomes organic, these animals must be reared to organic standards, and any further animals brought in must comply with the details listed in section 1.1.1. Sourcing Livestock.

When bringing animals onto a holding for rearing purposes, there are additional regulations which must be adhered to in order to achieve and maintain organic status:

- ✓ Calves must be less than six months old.
- ✓ Lambs must be less than 60 days old.
- ✓ Piglets must weight less than 35 kg.

All animals in this scenario must be brought in at weaning and reared on the holding.

1.1.3. Replacing Breeding Stock

When replacing breeding stock, ideally animals should be sourced from organic holdings. Where this is not possible, non-organic animals are allowed to be brought onto a holding for replacement purposes only. These must be kept in accordance with organic standards. When bringing in non-organic females, limitations on the number of non-organic breeding stock apply. The following criteria must be adhered to for non-organic animals:

- ✓ Only up to 10% of existing adult numbers for cows or equines per year can be brought onto a holding. This includes buffalo and bison.
- ✓ Only up to 20% of existing adult numbers of pigs, sheep and goats per year can be brought onto a holding.

- ✓ Only 1 animal, if there are already fewer than 5 pigs/sheep/goats or fewer than 10 cattle/equine on a farm can be brought onto that holding.

When farmers are significantly increasing their herd/flock size they are allowed to bring in up to 40% of their existing adult herd/flock numbers of non-organic animals. This is also true if they are introducing a change in breed, developing a new livestock enterprise or the herd/flock is a uncommon breed. Prior permission (in writing) must be obtained from the local organic certifier before this occurs to maintain organic status of the holding.

There are some additional exceptions to these limitations for bringing in non-organic breeding stock. For example, under cases of high mortality produced by health or catastrophic circumstances, a farmer may renew their herd/flock with non-organic animals. However, this must be authorised by the certifying organic body and only in exceptional circumstances which have severely reduced the organic flock/herd.

1.1.4. Biosecurity

Biosecurity measures are critical in all types of farming to avoid bringing disease into a holding. Biosecurity is not only necessary when bringing in new livestock, but when returning any livestock to a holding or during disease outbreak. Methods such as isolation, blood testing and TB testing in cattle should be adopted for bringing livestock onto the farm. Farmers may also consider buying from disease-free/high-health status herds and/or flocks and buying from direct, well-known sources to avoid increasing the risk of introducing disease. Once livestock are on the holding, methods such as double fencing between boundaries with other farms should be adopted to reduce risk of disease transmission. Where manure or other materials are brought-in from off-farm, or any equipment is shared or contracted, these should be free from disease or cleaned on site before use to avoid any disease transmission. Further information on cleaning under organic regulations can be found in Chapter Food Safety, section 3.4. Cleaning. The organic standards recommend that to further reduce the risk of buying in diseased stock, buying from markets or collection centres should be avoided. However, this is not prohibited.

1.2. Organic Production Systems

Once the holding has achieved organic status, there are various regulations and general advice on how the livestock must be kept, to maintain the organic status. These include criteria for feeding, housing, medication, welfare etc. These areas are discussed below, in further detail.

1.2.1. Feeding and Nutrition

In organic systems, nutrition is the key to managing animal health and maintaining a high health status of livestock. Unlike conventional systems, there are restrictions on what feedstuffs organic livestock can be fed in order to maintain organic status of a holding.

Farmers must meet the nutritional needs of their livestock at all stages of their development using a diet of organic feedstuff obtained from the holding or another organic holding/s, within the region of the farm. Ideally, organic farms will be 100% self-sufficient for feeding ruminant livestock, however up to 30% of their diet (based upon the yearly dry matter intake of feedstuff) can come from other local organic sources. The key is reducing off-farm reliance, but if necessary, products must be sourced from local, organic holdings.

Grazing of common land is acceptable, providing farmers can demonstrate that the land has not been treated with any prohibited products in the last 3 years. If non-organic livestock are also grazing the common land, there are further regulations which must be adhered to in order to keep the organic status of the livestock. For example, clear segregation (hefted animals), clear identification (ear tags), methods to prevent access to non-organic food and isolated handling/treatment facilities must be used. Where animals undergo transhumance, grazing of non-organic land is acceptable, providing this does not exceed 10% of the animals total dry matter intake of feed per year.

Any commercial, compound or blended bought-in feed, must come from a licensed supplier and comply with organic standards.

Encouraging home-grown feed and local grazing allows organic systems to be more sustainable than conventional systems through reducing food miles for bought-in feed. Any crops, pasture or hay used for feeding must also be grown organically, such that the use of synthetic fertilisers and pesticides are either avoided or approved for organic use.

The use of pesticides should be avoided and is only allowed in specific circumstances and on very rare occasions. Organic farming relies on the natural balance between plants and animals to prevent pests. For example, wildlife such as birds, beetles, specific insects (ladybirds) are encouraged, which eat common pests (such as slugs, aphids, caterpillars).

Synthetic fertilisers are avoided such that farmers and food producers select plants based on their nutritional properties. For example, using nitrogen-fixing plants (clover, legumes) alongside green manures, animal manure and compost to enrich soils. The land used for growing crops and pasture for organic grazing must have had a three-year period being free of prohibited materials before the first organic harvest can commence.

Management methods such as crop rotation, crop selection and careful selection of crop varieties which are at lower risk to disease, further reduces the risk of disease and enables farmers and food producers to farm organically without the need for synthetic fertilisers and pesticide use. For more information on pesticide and fertiliser usage in organic systems, see Chapter Food Safety, specifically 3. Food Safety: Up to the Farm Gate.

Where non-natural feed additives or supplements are used (vitamins, minerals), these must also be approved for the use under the organic standards. Exceptions for the use of non-natural feed additives or supplements occur where animal health and nutrition may be affected, or it is impossible to produce and/or preserve feed without their use. See Table 1a-1k for a list of products and substances that are authorized for use in organic livestock feed. In particular, the use of synthetic amino acids are prohibited in organic systems. In addition, methods such as force-feeding and feeding to encourage anaemia are also prohibited in organic systems.

1.2.2. Health, Disease and Injury

Routine health monitoring of animals is necessary, as with conventional systems. In organic systems, the aim is for disease management to be preventative rather than therapeutic, whereby improved management, husbandry and nutrition work to reduce the risk of disease occurring on the holding in the first place.

Details of how disease risk is managed and reduced must be included in the farm health plan and reviewed regularly. Organic farmers must also include preventative measures such as breed and strain selection in livestock, husbandry management practices, high quality feed and exercise, suitable stocking densities and enough housing maintained in hygienic circumstances on a holding. Recording these measures in the health plan demonstrate that animal health is being actively managed and disease/illness actively reduced. If/when disease problems occur, management must be reviewed and action taken accordingly, as well as the effectiveness of any action reviewed.

When considering animal health, husbandry practices which strengthen the animals' natural defence against diseases and work to enhance the immune system, must be applied. Examples of husbandry practices which aim to reduce disease risk include high biosecurity measures, grazing management to improve nutrition and enhance soil health, stockmanship and welfare assessments to monitor animal health, breeding management and culling management. It is recommended that animal health plans are overseen by a veterinary surgeon on-farm and reviewed annually to ensure maximum benefit.

Where animal welfare is concerned, high standards are achieved through access to open space and pasture as well as aiming to meet species-specific needs. Husbandry practices such as rotational grazing or grazing pastures with different animal species should help lower the parasite burden on each parcel of land. Frequent parasite monitoring of livestock will aid in assessing the effectiveness of any preventative measures being used. If animal health plans are appropriate, the use of veterinary medicines will be reduced drastically.

Where animals are sick and require medication, this must not be withheld to maintain organic status. Any animal that becomes sick or injured must be treated without delay. Where necessary, isolation in suitable housing may be required.

It is the responsibility of the farmer to ensure that any treatment or veterinary medicine used is licensed for organic use.

In organic systems, homeopathic products, phytotherapeutic products, trace elements, vitamins and minerals should be used in preference to chemically synthesised allopathic veterinary treatments or antibiotics. Acceptable products can be found in tables 1a-1k. In situations where these products are ineffective and untreated animals will suffer distress, pain and/or lasting harm, chemically synthesised allopathic treatments and/or antibiotics can be used under veterinary advice.

Table 1a. Products and Substances Allowed for use in Livestock feed: **Feed Material**

Product or Substance	Conditions of use
Organic feed materials from animal origin	
Fermentation (by-products) from non-organic feedstuffs or microorganisms of plant or animal origin whose cells have been inactivated-killed: a) Saccharomyces cerevisiae b) Saccharomyces carlsbergensis	

Table 1b. Products and Substances Permitted for use in Livestock feed: **Minerals**

Product or Substance	Conditions of use
Sodium	Sea salt Coarse rock salt Sodium chloride Sodium bicarbonate Sodium sulphate
Potassium	Potassium chloride
Calcium	Calcareous marine shells Maerl Lithothamne Calcium gluconate Calcium Carbonate
Phosphorus	Defluorinated monocalcium phosphate Defluorinated dicalcium phosphate Monosodium phosphate Calcium magnesium phosphate Calcium sodium phosphate Monosodium phosphate
Magnesium	Magnesium oxide (anhydrous magnesia) Magnesium sulphate Magnesium chloride Magnesium carbonate Magnesium phosphate

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Table 1c. Products and Substances Allowed for use in Livestock feed: **Preservatives**

Functional Group	Product or Substance
E 200	Sorbic acid
E 236	Formic acid
E 237	Sodium formate
E 260	Acetic acid
E 270	Lactic acid
E 280	Propionic acid
E 330	Citric acid

Table 1d. Products and Substances Allowed for use in Livestock feed: **Antioxidants**

ID No or Functional Group	Product or Substance
1b306(i)	Tocopherol extracts of vegetable oils
1b306(ii)	Tocopherol-rich extracts of vegetable oils (delta rich)

Table 1e. Products and Substances Allowed for use in Livestock feed: **Binders and Anti-Caking Agents**

ID No or Functional Group	Product or Substance
E 412	Guar gum
E 535	Sodium ferrocyanide (max dose rate 20 mg/kg) NaCl calculated as ferrocyanide anion)
E 551b	Colloidal silica
E 551c	Kieselguhr (diatomaceous earth, purified)
1m558i	Bentonite
E 559	Kaolinitic clays, asbestos free
E 560	Natural mixtures of steatites and chlorite
E 561	Vermiculite
E 562	Sepiolite
E 566	Natrolite-Phonolite
1g568	Clinoptilolite of sedimentary origin
E 599	Perlite

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Table 1f. Products and Substances Allowed for use in Livestock feed: **Silage Additives**

ID No	Product or Substance	Conditions of use
1K 1K236	Enzymes, micro-organisms Formic acid	It is limited to silage production when weather conditions do not allow enough fermentation. The use of formic, propionic acid and their sodium salts is permitted for silage production only when weather conditions do not allow adequate fermentation.
1K237	Sodium formate	
1K280	Propionic acid	
1K281	Sodium propionate	

Table 1g. Products and Substances Allowed for use in Livestock feed: **Sensory Additives**

ID No	Product or Substance	Conditions of use
2b	Flavouring compounds	Only extracts of agricultural products
	Castanea sativa Mill: Chestnut extract	

Table 1h. Products and Substances Permitted for use in Livestock feed: **Nutritional Additives**

ID No	Product or Substance	Conditions of use
3a	Vitamins and Preservatives	1. Must have been derived of agricultural products, or 2. If synthetic vitamins are used, only the same vitamins of agricultural products can be used for monogastric and aquaculture animals. Just synthetic vitamins A, D and E, which are the same vitamins from agricultural products, can be used for ruminant animals. The use of such vitamins can be used if the Member State approves them. If a farmer wants to take advantage of this opportunity, he must justify why they should use these vitamins.
3a290	Betaine anhydrous	✓ Just for monogastric animals ✓ Just of natural origin and when available of organic origin

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Table 1I. Products and Substances Allowed for use in Livestock feed: **Trace Elements**

ID No or Functional Group	Product or Substance	Conditions of use
E1 Iron 3b101 3b103 3b104	Iron (II) carbonate (siderite) Iron (II) sulphate monohydrate Iron (II) sulphate heptahydrate	
3b201 3b202 3b203	Potassium iodide Calcium iodate, anhydrous Coated granulated calcium iodate anhydrous	
3b301 3b302 3b303 3b304 3b305	Cobalt (II) acetate tetrahydrate Cobalt (II) carbonate Cobalt (II) carbonate hydroxide (2:3) monohydrate Coated granulated cobalt (II) carbonate hydroxide (2:3) monohydrate Cobalt (II) sulphate heptahydrate	
3b402 3b404 3b405 3b409	Coper (II) carbonate dihydroxy monohydrate Copper (II)oxide Copper (II) sulphate, pentahydrate Dicopper chloride trihydroxide (TBCC)	
3b502 3b503	Manganese (II) oxide Manganous sulphate, monohydrate	
3b603 3b604 3b605 3b609	Zinc oxide Zinc sulphate heptahydrate Zinc sulphate monohydrate Zinc chloride hydroxide monohydrate (TBZC)	
3b701	Sodium molybdate dihydrate	
3b801 3b810, 3b811, 3b812, 3b813 and 3b817	Sodium selenite Selenised yeast inactivated	

Table 1j. Products and Substances Allowed for use in Livestock feed: **Zotechnical Additives**

ID No or Functional group	Product or Substance	Conditions of use
4a, 4b, 4c, 4d.	Enzymes and micro-organisms in the category "Zootechnical additives"	

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Table 1k. Products and Substances Allowed for use in Livestock feed: **Other**

Product or Substance	Conditions of use
Products of sustainable fisheries	✓ When production takes place without chemical solvents ✓ Their use is limited to non-herbivorous animals ✓ Only young animals are allowed to use Fish protein hydrolyzate
GUIDANCE: The source have to be certified independently as sustainable, such as by the Marine Stewardship Council.	
Non-organic spices, herbs and molasses provided that:	✓ Only when organic is not available. ✓ Must be produced or prepared without chemical solvents, and ✓ Use is limited to 1% of the feed ration of a given species calculated as a percentage of the dry matter of feed of agricultural origin
GUIDANCE: If a farmer uses non-organic spices, herbs or molasses they must indicate that the organic form is not available.	

Antibiotics and wormers can be used when disease/illness is present and when a derogation is granted by the organic certifying body (see Chapter Food Safety, section 3.2. Medicine Residues within Organic Derogations). Some antibiotics are prohibited in organic systems so veterinary advice must always be sought in order to uphold organic status of a holding.

As organic systems work on the principles of successful management to avoid the need for intervention, the routine use or preventative use of wormers and antibiotics is banned. These products should be used when disease or injury occur and under veterinary advice.

In organic systems, the use of growth hormones, cloning and genetic engineering is prohibited. Genetically modified organisms (GMOs) are classified in the standards as "excluded methods" and are forbidden.

Nutritional supplements or veterinary products which affect growth can only be used when there is a nutritional deficiency that can't be resolved through feed alone. They cannot be used to increase growth rate or production, as this is banned in organic systems.

Hormones or substances that control reproduction can only be used for welfare reasons (such as inducing parturition) or in one-off, individual disorders (e.g. a cow not coming into heat). Hormones cannot be used to manipulate normal reproduction cycles.

Artificial insemination is permitted in organic systems, but cloning or embryonic transfer is prohibited.

Where products have been used or applied to livestock, animals can only be sold when the appropriate time period has passed since using the product, which is known as a withdrawal period. For organic animals, extended withdrawal periods (beyond the manufacturers'

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recommended period) are required before selling products as organic. Further details on derogations for medical products can be found in Chapter Food Safety, section 3.2. Medicine Residues within Organic Derogations.

In all cases, when any treatment is administered, animals must be clearly identifiable and appropriate records kept (see Chapter Food Safety, section 3.1.5. Veterinary Records for further information).

1.2.3. Animal Welfare

Providing animals with good animal welfare should ensure "good physical health and functioning of animals", minimise unpleasant states (such as fear, pain) whilst freely allowing animals to express normal behaviours.

For conventional farms in Europe, the law provides "minimum standards" for all livestock, which many argue is failing to adequately protect livestock. EU Organic law requires higher standards than the basic legal requirements for animal welfare. Organic regulations require animal husbandry practices and housing (where used) to meet species-specific physiological, developmental and behavioural needs at all times and usually goes above and beyond "minimum recommended standards." Animal welfare will be monitored during any organic inspection. Examples of welfare outcomes which will be identified during inspections can be found in Table 2, categorised by species.

Table 2. Species specific welfare outcomes which will be assessed during an organic inspection to ensure animal welfare standards are achieved

Species	Welfare Outcome measure
Dairy Cow	Mobility, which includes lameness Body condition Cleanliness Hair loss and swelling Broken tails Response to stockperson Mastitis record Calf/heifer survivability record Cull and casualty cow record
Beef cattle	Lameness Cleanliness Body condition score (adult breeding animals) Hair loss and lesions or swellings Cattle which need further care Animals with respiratory signs Pneumonia treatments Mortality records (see table 2 in Chapter Food Safety)

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Sheep	Lameness Body condition score Dirtiness Fleece loss Sheep which need further care Mortality records (see table 2 in Chapter Food Safety)
Pigs	Enrichment use Lameness Ear-flank biting lesions, other body marks Pigs which need further care Hospital pens Manure on body Leg swellings Skin conditions Tail lesions (finishers) Shoulder and vulva lesions and body condition (dry sows) Mortality records (see table 2 in Chapter Food Safety) Antibiotic records
Laying hens	Feather loss Bird dirtiness Antagonistic behaviours as aggressive behaviour and injurious feather pecking Birds which need further care Mortality records
Broiler hens (still in development)	Bird distribution Air quality Panting Enrichment Dirtiness Walking ability Birds which require culling Dead birds and runts Litter condition Behaviour Mortality records Antibiotic records Post-slaughter records

In organic systems, animals must be able to move freely both outdoors and when housed, therefore tethering or holding the animal in isolation is prohibited (except for short periods where the process is justified, e.g. for welfare, veterinary or safety reasons).

In addition, stocking densities in organic systems generally allow more space than conventional systems, giving animals more freedom to express natural behaviours. In organic systems, stocking densities are calculated to not exceed the equivalent of 170 kg of nitrogen per hectare per year applied to the land from manure – both directly from animals and from spreading. Examples of stocking densities for the UK can be found in table 3. In general, stocking densities are species specific and behavioural needs will be affected by breed, age, sex and size of the group of animals.

Table 3. Stocking densities for organic systems in order to meet the 170 kg of nitrogen per hectare per year limit

Livestock type	Category	Maximum stocking rate per hectare
Cattle	Calves up to 2 months	21
	Dairy cows 2 months to < 12months	5
	Dairy cows >12 months to first calving	3
	Dairy cows after first calf	2
	Beef cows or steers 2 months to <12 months	5
	Beef cows or steers >12 months to <24 months	3
	Beef cows or steers from 24 months for slaughter	3
	Females of 24 months for breeding, <500 kg	3
	Females of 24 months for breeding, >500 kg	2
	Bulls, non-breeding > 2months	3
	Bulls for breeding 2 months to <24 months	3
	Bulls for breeding >24 months	4
Sheep	6 months to 9 months	85
	From 9 months to first lambing, tupping for slaughter	121
	After lambing or tupping <60 kg	22
	After lambing or tupping >60 kg	14
Goats		11
Pigs	7 kg<13 kg	170
	13 kg<31 kg	40
	31 kg<66 kg	22
	66 kg> intended for slaughter	16
	Breeding sow before first litter	15
	Sow with litter up to 7 kg	9
	Breeding boar 66 kg-150 kg	14
	Breeding boar >150 kg	10

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Poultry	Layers <17 weeks	800
	Layers >17 weeks	320*
	Broilers	510
	Breeding stock <25 weeks	590
	Breeding stock >25 weeks	240
	Male turkey	140
	Female turkey	190
	Ducks	230

Taking into account the time the birds are not housed is a factor to consider when calculating storage requirements. In general, free-range laying hens are housed 80% to 90% of the time. The figures given assume that 80% of excrement accumulates in buildings. For organic birds this will be less.

Practices such as outdoor wintering, reduced housing periods, greater access to open pasture and outside spaces are just some of the methods that increase animal welfare, and therefore animal health is improved too. In organic systems, livestock generally spend more time outdoors (particularly in comparison to conventional dairy and pig systems) which allow animals to exhibit natural behaviours more often, reducing stress. Landless livestock systems are prohibited in organic systems as all herbivores must have permanent access to pasture. Temporarily withholding access is allowed when animal health or welfare prevent this, the weather status and the state of the ground are inadequate or there are community or national restrictions which relate to animal or human health requiring animal housing.

With animals spending more time outdoors, there are potential negative welfare implications. Measures of protection must be provided against predation, wind, rain, sun and extreme temperatures. These measures include shade and other protection and must be suitable for the stock, breed, and climate, and can be natural or artificial. Examples of protection could include trees, hedges, rocks, ridges, bales, buildings, long grass, scrub, tussocks, dry stone walls, and field shelters. Extreme temperatures will limit the productivity of livestock and potentially result in health problems. Providing shade and shelter will allow multiple benefits such as increased survival rates of young stock, better food conversion, better growth rates and increased pasture growth and utilisation.

In organic systems, animal mutilations are restricted. Farmers are not allowed to routinely carry out procedures such as tail docking, beak trimming, teeth cutting, disbudding or dehorning. These procedures are only allowed for specific reasons such as safety, to improve

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animal health, welfare or hygiene and must be authorised by the organic certifying body. They are decided on a case-by-case basis for specific holdings. Castration is only allowed to maintain quality of products and to maintain any traditional production practices. Where any mutilations are authorised, adequate analgesic and/or anaesthesia must be used, the animal must be at an appropriate age required by the regulations, and competent personnel must carry out the procedure. Details of any planned tail docking, disbudding or dehorning must be detailed in the animal health plan.

1.2.4. Animal Housing

The main aim of organic farming is to ensure that all animals can express natural, species-specific behaviours.

Where the climate and soil type provide adequate conditions for animals to live outdoors, housing is not essential. However, shelter must be available in some form whether natural or artificial. Where shelter is not sufficient or housing is required, it must provide enough light, comfort, space and adequate room for animals to move freely as well as express natural behaviours. Animals have to be able to freely lie down, turn around, groom themselves and make natural movements as stretching. Animals must be able to move freely both in the outdoors and when housed. Tethering or holding the animal in isolation is prohibited, except for short periods where the process is justified by requirements of welfare, veterinary care or safety.

If isolation occurs, animals must be able to see other animals. It must also provide adequate ventilation and heating to ensure that temperature, humidity, air circulation, dust levels and gas concentration are kept within non-toxic limits. All housing must be maintained to avoid unnecessary injury and kept clean and disinfected to avoid disease build up and cross-infection. Species-appropriate bedding must be used and regularly changed to remove faeces and urine exposure. Uneaten and/or spilt food must also be removed to prevent disease, smell and avoid attracting pests. For more information on cleaning animal housing under organic standards, see Chapter Food Safety, section 3.4. Cleaning.

1.3. Species-Specific Organic Production Systems

The following sections will discuss the specific criteria for individual livestock species to achieve organic status. There may be some elements of crossover between different livestock species already covered in section 1.2., but this this section aims to highlight species specifications.

1.3.1. Dairy

Organic dairy farming is on the rise, almost doubling since 2007 across Europe. With varying climatic regions, topology, national and regional regulations, infrastructure and traditional as well as more commercial management practices, European dairy farming varies greatly across the continent. Organic dairy farms have generally higher use of pasture and roughage in diets, less use of concentrates and on average a lower use of medicine than non-organic farms. When comparing organic dairy farming with conventional dairy farming, the main differences occur in five key areas; diet, animal health, animal welfare, housing and breeding. These are discussed in more detail below:

Nutrition and Feeding

In comparison to conventional dairy management, organic cows must spend as much time outdoors as possible and must have access to an outdoor space (weather permitting). On average, organic cows have access to pasture 200 days per year. Zero grazing (animals kept indoor and fed cut grass or other feed) is banned under organic regulations. This is one of the main differences organic farms compared to conventional systems, as non-organic cows are generally fed imported, and often genetically modified animal feed. Organic cows cannot be fed genetically modified feed and must also have access to pasture during the growing season. At least 60% of their dry matter intake must be grass-based either fresh, dried fodder, roughage or silage. Guidance on daily dry matter intake for dairy cows can be found in Tables 4 and 5. During the early stages of lactation, a reduction to 50% of their diet being fresh or dried fodder is acceptable, although this period can only last up to a maximum of 3 months.

Table 4. Guidance on daily dry matter intake (DMI) for a Lactating cow

Weight (kg)	Daily DMI (kg) *
400	14.0
450	15.75
500	17.5
550	19.25
600	21.0
650	22.75
700	24.5
750	26.25

*Daily DMI has been calculated as 3.5% of live weight

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Table 5. Guidance on daily dry matter intake (DMI) for growing beef cattle, beef suckler cows and young dairy stock

Weight (kg)	Daily DMI (kg) *
100	2.5
150	3.75
200	5.00
250	6.25
300	7.5
350	8.75
400	10.00
450	11.25

*Daily DMI has been calculated as 2.5% of live weight

Where animals are fed ad lib this must be done in a way to ensure that bullying and conflict do not occur. This means adequate feed space must be given to ensure that all animals can feed at the same time, which will reduce any aggression or conflict over food. Conventional systems are given on average a third more concentrate feed than organic cows. As a result, organic dairy cows have around a 20% lower milk yield in comparison to conventional dairy cows, but their milk production is more sustainable, which helps protect and increase the animals' health and welfare in the organic system.

Positioning of water troughs must also be planned to avoid unnecessary conflict. There should be enough water available for 10% of the herd to drink at any one time. The height of drinkers should also be adequate so that all ages of animals have access to water. This includes animals that are pre-weaning.

Allowing animals these minimum standards as well as access to outdoor grazing results in high animal welfare and allows animals to exhibit natural behaviours, thereby reducing stress and disease within the herd. Exceptions are made during transhumance and where catastrophic circumstances occur (infectious disease epidemics, contamination of feedstuff with toxic substances, exceptional weather conditions and fire).

Young Stock

Calves are fed natural feed, such as organic milk, preferably their own maternal milk for a minimum of 12 weeks post-birth. Maternal milk is described as that from the young animal's mother. Natural milk is described as that from the mammary glands of an animal. Natural milk from another species can be fed providing it meets the nutritional needs and health requirements of the species it is being fed too. Organic milk and milk products are only classified as "organic" providing they have been under continuous organic management for a minimum of one year. Milk powder is classified as a natural source of milk, providing it only contains milk powder and no additives. There must be an emergency plan in place for a source of organic colostrum which should be specified in the health plan. In an emergency, non-organic milk replacer can be fed to young animals for up to 72 hours. If this is used after 72 hours the animal is no longer classified as organic.

Calves must receive cows' milk until they are at least 12 weeks old, then are allowed access to pasture for grazing in the warmer months. In conventional systems, calves are separated at birth to avoid milk loss. Research into short term suckling has shown to be more advantageous than removing the calves at birth for both the cow and the calf. There are direct animal welfare improvements for both cow and calf as well as health benefits, in terms of calf immunity and the incidence of mastitis in the cow. However, there can be increased separation stress, therefore animal welfare needs to be monitored, depending on the separation method being used. Weaning can only occur after the minimum ages have been achieved and once they are taking enough quantities of solid food. To increase animal welfare during weaning, it is suggested that calves should be housed in groups of similar ages, encouraging natural behaviours to be expressed and reducing anxiety where a surrogate/retired cow is not present. It also encourages skills learning. In some systems, a surrogate or retired cow can be housed with the calves to improve animal welfare during separation from maternal cow.

Animal Health

An animal health plan must be in place which is produced with the farmer or food producer's veterinary surgeon as part of the conversion plan. It must be in place prior to conversion to organic. Animals are treated as required (with necessary products), but using the health plan, this process is more formalised. Withdrawal periods apply and are either doubled or trebled to achieve organic compliance (see Chapter Food Safety, section 3.2. Medicine Residues within Organic Derogations).

In dairy herds, mastitis can be a common occurrence. For organic dairy systems, antibiotics can be used routinely in clinical cases where permission from a veterinary surgeon has been obtained. This can only be used where no other treatments could be effective. A maximum of two courses of antibiotics within a 12-month period are permitted. Where this is exceeded, the cow must be removed from the organic milking herd. Where justification occurs in the Animal Health Plan on the grounds of animal welfare, veterinary treatments, licensed for the purpose, can be used to treat the following external parasites:

- ✓ Biting flies, lice, ticks, etc.: the use of synthetic pyrethroid insecticides as a topical treatment.
- ✓ Mange in cattle: the use of Ivermectin as an injection.

Due to the concentrated nature of the chemical, pouring processes should be avoided if possible.

Where lameness occurs in the herd, this could be a sign that inappropriate floor surface or bedding is being used, resulting in slippery flooring or directly damaging the animals' feet. It could also be a sign of slurry build-up under foot, resulting in foot health problems. Regular cleaning and appropriate housing/bedding should reduce the risk of lameness in the herd. More information can be found in the 'housing section' below on appropriate bedding for this species. Information on cleaning under organic regulations can be found in Chapter Food Safety, section 3.4. Cleaning. Breeding strategies to combat animal health related issues in organic systems are discussed in Chapter Breeding.

Animal Welfare

Increased use of pasture for cows improves animal welfare in organic systems. It could also be described as more sustainable than conventional dairy systems in terms of eutrophication potential.

Appropriate stocking densities must provide comfort and wellbeing of animals. Swellings or lesions on cattle may be an indicator that stocking densities are too high. Where space is limited, animals are more likely to injure themselves on each other or obstructions in walkways. Stocking densities would need to be reassessed where continuous injuries occur.

In terms of animal welfare, some procedures are prohibited, such as tail docking and dehorning (used to avoid injury to the animal or other animals it is housed with) which must be done using methods that minimise stress.

Tethering is generally prohibited in organic systems. However, there are exemptions to this rule where climatic, geographical or structural constraints result in a requirement for this management method. Where this does occur, the animal must have daily access to pasture during the grazing season, or at least two in a week access to an open-air exercise area, when pasture status are not adequate. This is only acceptable in certain mountainous regions of mainland Europe and must be authorised by competent organic authority before taking place.

Another area to consider in organic dairy farming is the role of unwanted male dairy cows. Ideally, there should be a plan in place within organic systems for these male calves. Some organic standards go as far as stating that a plan 'must' be in place. Practices such as crossbreeding on a specialised dairy breed allows offspring to be dual-purpose, making male calves more valuable. This is discussed in more detail in Chapter Breeding, sections 2.3. Crossbreeding and 3.1. Dairy.

Calf crates have been banned in the EU since 2007 and individual housing prohibited after the animal is seven days old.

Housing

Stocking densities in organic dairy systems generally allow more space than conventional dairy farming systems. There are minimum standards in terms of flooring space for cattle in organic systems. Specific details can be found in table 6.

Table 6. Minimum housing area for cattle in organic systems

Class of animal	Minimum indoor space m² per head (net area available to animals)	Additional area required m² per head * (indoors or outdoors, excluding pasture)	Total m² per head
Breeding and fattening cattle:			
Up to 100 kg	1.5	1.1	2.6
Up to 200 kg	2.5	1.9	4.4
Up to 350 kg	4.0	3.0	7.0
Over 350 kg	5.0 with a minimum of 1m²/100kg	3.7 with a minimum of 0.75m²/100kg	8.7 with a minimum of 1.75m²/100kg
Dairy cows	6.0	4.5	10.5
Bulls for breeding	10	30*	40
	When a bull is fully mature and used for breeding then the space allowance for 'Bulls for breeding' should be applied, if they are adolescent bulls, not yet at maturity the space requirements for 'breeding and fattening cattle' should be applied for all the animals in the group. If mature bulls are housed within a group made up of different ages or types e.g. Cows or adolescent bulls, then the space calculation should be made for the other cattle in the group with the additional space for the bull.		

2. *The additional area for bulls is not required if the bull is temporarily being run with cows provided the additional area is provided for all other animals within the group Open air areas may be partially covered.

3. You do not need to provide the outdoor exercise area during the winter months provided that the winter-housing system allows freedom of movement and the livestock have access to pasture during the grazing period.

(EC) 889/2008 Art. 10(4); Art. 14(1)(3); Annex III

Housing is not essential where the type of climate and soil in the area is proper for outdoor living all year round. However, shelter must be available in some form whether natural or artificial. Where housing is required, it must provide adequate insulation, ventilation and heating to provide that temperature, humidity, air circulation, dust levels and gas concentration are kept within non-toxic limits.

Organic standards state that at least half of the housing for livestock species (mammal) must be a clean, comfortable and dry resting/laying area. It must also be solid and not slippery, slatted or a grid structure. This could be classified as a bedding area. 100% slatted is not permitted in organic systems. In addition, cubicles are permitted, but it must be possible to demonstrate that there are enough cubicles for the number of stock and that the cubicles are an adequate size to meet the individual needs of each cow. The size, shape and weight of cows will affect the size of cubicles required. It is expected that there are 5% more functioning cubicles than number of stock in the herd to provide a cubicle is always available. This will increase animal welfare as it will reduce potential bullying, fighting over limited resources and ensure all animals can express natural behaviours freely.

Where cubicles are present, dry bedding material must be provided. Any natural materials used for bedding must not have been treated with forbidden substances which would render them inorganic. Examples of such materials include straw (conventional), sand, wood shavings and untreated sawdust. Natural materials like bracken, bean haulm and rushes can also be used. Rubber mats, water beds, mattresses or other cushioned materials alone are not classified as suitable bedding.

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Calves cannot be kept in separate pens once they are seven days old. This is prohibited as it prevents natural behaviours being expressed. Cattle in their final stages of finishing can be kept in well bedded, spacious yards providing that the period is no more than 3 months and doesn't equate to greater than one fifth of their lifetime.

Breeding

It is recommended that breeding herds are established before entering into the conversion process. This is due to limitations on the number of animals that can be brought in from "off farm" during anyone year relative to herd size (see above for specific criteria). Where replacement heifers come from 'off farm', they must be from organic herds. Where this is not possible, permission from the organic standards authority must be achieved and a maximum of 10% of the herd size can be bought in. See section 1.1.3. Replacing Breeding Stock. More detail on specific breeding strategies, characteristics, genetics and breeds for organic dairy systems can be found in chapter Breeding.

1.3.2. Beef

Demand for organic beef has increased rapidly over the past 10 years globally. Many of the organic beef farms across Europe were already extensively outdoor beef farming systems, allowing easy conversion to organic farming. Consumers are also becoming aware of the increased health benefits for organic or pasture-fed beef. Combined with a proactive attitude towards a sustainable future, organic beef farming becomes more popular. Confusion between consumer and product can offer with terms like grass-fed, organic and pasture-fed. For example, "grass-fed beef" is also becoming popular, and some grass-fed products are produced under organic regulations. However, the term "grass-fed beef" is not well defined and doesn't necessarily mean the product is organic. Grass-fed beef as a standalone is not as regulated as that of organic beef.

Nutrition and Feeding

As with organic dairy systems, organic beef animals spend as much time outdoors as possible and must have access to an outdoor space (weather permitting). Zero grazing (animals kept indoor and fed cut grass or other feed) is banned under organic regulations, as is the use of genetically modified animal feed. Organic cows must also have access to pasture during the growing season. At least 60% of their diet must be grass based either fresh, dried fodder, roughage or silage. This is based on their dry matter intake. Guidance on daily dry matter intake for beef cattle can be found in Table 5.

Where animals are fed ad lib they must be fed in a way which ensures that bullying and conflict do not occur. This means adequate feed space must be given to provide that all animals can feed at the same time, which will reduce any aggression or conflict over food. Conventional beef systems are given on average a third more concentrate feed than organic cows which has an effect on end-product taste. With organic beef, due to the animals' diet being primarily grass and roughage rather than concentrate, growth is slower, and there is a clear difference in taste for grass-fed beef compared with grain-fed beef.

Positioning of water troughs must also be considered to avoid unnecessary conflict. There should be enough water available for 10% of the herd to drink at any one time. The height of drinkers should also be adequate so that all ages of animals have access to water. This includes animals that are pre-weaning.

Allowing animals these minimum standards, as well as access to outdoor grazing, results in high animal welfare and allows animals to exhibit natural behaviours, reducing stress and disease within the herd. Exceptions are made during transhumance and where catastrophic circumstances occur (infectious disease outbreaks, contamination of feedstuff with toxic substances, exceptional weather conditions and fire.

Animal Health

Beef cattle specific animal health information is the same as that listed in the organic dairy cow section, 1.3.1., except that mastitis is not a common problem in organic beef cattle. Lameness and foot health related issues are similar to that of dairy systems. Internal parasites are also an area of concern in organic beef systems due to the extent of outdoor grazing. Management methods such as clean grazing or rotational grazing to control parasite burden need to be adopted in these systems to avoid the use of anthelmintics. This is discussed in more detail in section 1.3.3. Sheep, in the animal health section. Breeding strategies to combat animal health related issues in organic systems are discussed in Chapter Breeding.

Animal Welfare

Animal welfare information for beef cattle is the same as that listed in the organic dairy cow section, 1.3.1., although organic beef cattle are likely to spend less time indoors than organic dairy cows.

Housing

One of the major differences between organic and conventional beef farming is that winter housing is much more spacious in organic systems than in conventional. In organic systems, 1.0 m^2 of housing space is required for every 100 kg live weight. For organic beef specific housing area requirements see table 6. Other organic cattle specific housing information is the same as that listed in the organic dairy cow section, 1.3.1.

Breeding

Organic cattle specific breeding information is the same as that listed in the organic dairy cow section, 1.3.1. More detail on specific breeding strategies, characteristics, genetics and breeds for organic beef systems can be found in Chapter Breeding.

1.3.3. Sheep

Sheep farming is built upon pastoral grazing that works with the environment. In some parts of the world, particularly UK sheep farming, sheep are a useful tool for tackling and mitigating against threats such as climate change, flooding and soil degradation. One of the major differences with organic and conventional sheep farming is the use of anthelmintics, antibiotics and other medicines. This is discussed in more detail below.

Nutrition and Feeding

In order to meet the nutritional needs of sheep in organic systems, they need to be able to utilise the forage available to them at varying times of the year. During different grazing seasons, there will be varying levels of fodder available. Organic systems need to keep breeds that can convert forage into energy efficiently. At least 60% of the daily diet of organic sheep must consist of fresh or dried fodder, silage of roughage except for periods when animals are under transhumance. This is calculated on a dry matter basis. Guidance on daily dry matter intake for sheep can be found in Table 7. In total, at least 60% of their annual diet must come from the holding to maintain organic status. Where this is not possible, off farm feed must come from local organic producers within the area. For sheep producing organic milk, a reduction to 50% of their diet must be fresh or dried fodder during the early stages of lactation. This period can last a maximum of 3 months. Organic dairy systems may experience a lower milk yield than conventional systems, but their product can be classified as higher quality.

Table 7. Guidance table on daily dry matter intake (DMI) for Sheep and Goats

Weight (kg)	Daily DMI (kg) *
10	0.25
20	0.50
30	0.75
40	1.00
50	1.25
60	1.50
70	1.75
80	2.00

*Daily DMI has been calculated as 2% of live weight

Where animals are fed ad lib they must be feed in a way which ensures that bullying and conflict do not occur. This means adequate feed space must be given to provide that all animals can feed at the same time, which will reduce any aggression or conflict over food. For sheep that are not fed ad lib, the following guidelines should provide adequate space:

- ✓ Feeding concentrates: 45 cm of trough space per ewe.
- ✓ Feeding hay and silage: 12-15 cm of trough space per ewe.

Note: Considerations must be made for the absence or presence of horns as well as the size of the sheep feeding.

Positioning of water troughs must also be considered to avoid unnecessary conflict. The height of drinkers should also be adequate so that all ages of animals have access to water. This includes animals that are pre-weaning.

Allowing animals these minimum standards as well as access to outdoor grazing results in high animal welfare and allows animals to exhibit natural behaviours, reducing stress and disease within the flock. Exceptions are made during transhumance and where catastrophic circumstances occur (infectious disease outbreaks, contamination of feedstuff with toxic substances, exceptional weather conditions and fire).

Young Stock

Lambs must be fed organic milk (from the ewe or reconstituted milk) for a minimum of 45 days post-birth. Maternal milk is that from the young animal's mother; natural milk is that from the glands of an animal. Natural milk from another species can be fed providing it meets the nutritional needs and health requirements of the species it is being fed to. Organic milk and milk products can only be classified as "organic" if they have been under continuous organic management for a minimum of one year. Milk powder is defined as a natural source of milk, providing it only contains milk powder and no additives. An emergency plan must be in place for a source of organic colostrum which should be specified in the health plan. In an emergency, non-organic milk replacer can be fed to young animals for up to 72 hours. If this is used after 72 hours the animal is no longer classified as organic. Lambs receive milk until they are at least 45 days old and are allowed access to pasture for grazing in the warmer months. Weaning can only be completed after the minimum age has been achieved and once the lambs are taking enough solid food.

Animal Health

An animal health plan must be in place which is produced with the farmer or food producer's veterinary surgeon as part of the organic conversion plan and must be in place prior to conversion to organic. Animals can be treated for health problems as and when required (with organically approved products), but using the health plan, this process is more formalised. Withdrawal periods for drugs and treatments apply and are either doubled or trebled to achieve organic compliance (see Chapter Food Safety, section 3.2. Medicine Residues within Organic Derogations).

One of the major differences between organic and non-organic sheep farming is the methods used to control and prevent disease. The routine use of anti-parasitic wormers is banned in organic systems and farmers must use other methods to control internal parasites in their organic sheep flocks. There are three methods for avoiding parasites in organic systems which are preventative methods, evasive methods or dilution methods.

Preventative methods include routine faecal egg counting to monitor worm burden or clean grazing. Using these in combination is a good tool adopted by organic farmers to avoid infestation in their flocks and the need for chemical intervention.

Clean grazing is a management practice, whereby sheep are put onto specific pastures which have low or no worm infestation. Ideally uninfected sheep are grazed on parasite-free pasture, which are pastures which have not been grazed previously by sheep or lambs for a long enough period of time to break the parasite's life cycle.

Dilution strategies use other methods such as grazing pastures which have undergone arable practices between grazing (which would remove potential parasite infestations) or grazing with another resistant species between sheep grazing. For example, grazing with cattle or horses before sheep would help to reduce the parasite burden in the soil. Reducing stocking rates (which will be lower in organic systems anyway) will also assist in evading infection.

Evasive strategies are aimed at avoiding disease by moving ruminants regularly. For example, rotational grazing could be used, whereby sheep are grazed in high numbers on smaller parcels of land for short periods of time (around 1 day per parcel) and then moved onto another parcel of land. By the time they come back to re-graze the initial parcel of land it will have been untouched for long enough to be classified as "'clean" or low infestation risk. The use of clean grazing is particularly important in organic systems when young lambs (and calves) are weaned, as their immune system will still be naive. Providing clean grazing at and during weaning (a time of stress) should aid in keeping the lambs healthy without the need for chemical intervention. As detailed earlier, should any animal become infected with parasites, anthelmintics could be used under the advice of a veterinary surgeon.

Another area where organic sheep farming differs from conventional farming is the use of treatments for external parasites. Veterinary treatments licensed for this purpose may be used in the treatment of the following external parasites, if justified in the Animal Health Plan on animal welfare grounds:

- ✓ Biting flies, lice, ticks, etc.: the use of synthetic pyrethroid insecticides as a topical treatment.
- ✓ Scab on sheep: the use of Ivermectins (in Injectable form).
- ✓ Blowfly strike on sheep: the use of Cyromazine as a preventative treatment in high risk areas;
- ✓ Footrot: the use of Zinc sulphate, Iodine, Benzalkonium chloride, footrot vaccine.
- ✓ Orf: The use of an Orf vaccine, Homoeopathic remedies.

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Due to the concentrated nature of the chemical, pouring processes should be avoided if possible.

The use of organophosphorus dips for controlling diseases such as sheep scab is permitted only when, prior to their use, the operator has demonstrated to the pleasure of OF&G that a convenient alternative is not available, and that other management techniques and inputs can be anticipated not to be effective. Approval must be obtained prior to its use. Where organophosphate (OP) treatments are applied, it is not appropriate to sell the fleece organically for at least 12 months, during which time the livestock must have undergone at least one complete cropping.

Where lameness occurs in the flock, this could be a sign that inappropriate floor surface or bedding is being used, resulting in slippery flooring or directly damaging the animals feet. It could also be a sign of bacterial build up under foot resulting in foot health issues. Regular cleaning and appropriate housing/bedding should reduce the risk of lameness in the flock. More information on cleaning under organic regulations can be found in Chapter Food Safety, section 3.4. Cleaning. Appropriate diet and high nutrition should also help combat animal health.

Breeding strategies to combat animal health related issues in organic systems are discussed in Chapter Breeding.

Animal Welfare

Sheep farming systems are pastoral in nature, and therefore stock spend the majority of their lives outdoors. Shade and shelter are particularly important for organic sheep farms for both protection from the elements as well as providing protection from predators for young stock.

Mutilations are prohibited in organic systems as explained earlier. However, some practices are acceptable under veterinary advice and using the appropriate pain relief. Tail docking and castration may be justified on animal health grounds as well as for product quality. Seek veterinary advice.

As mentioned above, tethering is generally prohibited in organic systems, however “lamb adopter” equipment may aid lamb adoption at lambing time. This would only be for a short period and the animal must still have access to pasture daily during the grazing season or at least two in a week access to an open-air exercise area, where pasture status is not adequate.

Housing

Housing is not essential where the climate and soil type is appropriate for outdoor living all year round. However, shelter must be available in some form whether natural or artificial. Where housing is required, it must provide adequate insulation, ventilation and heating to provide that temperature, humidity, air circulation, dust levels and gas concentration are kept within non-toxic limits.

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Stocking densities in organic systems generally allow more space than conventional farming systems. There are minimum standards in terms of flooring space for sheep in organic systems. Specific details can be found in table 8. Where animals are housed, appropriate bedding must be provided in line with organic standards.

Table 8. Minimum housing area for sheep and goats in organic systems

Class of animal	Lying area or indoor area m^2 per head	Outdoor exercise area required m^2 per head (Excluding pasture)	Total m^2 per head
Sheep/goat	1.5	2	3.5
Lamb/kid	0.35	0.5	0.85

2. You do not need to provide the outdoor exercise area during the winter months provided that the winter-housing system allows freedom of movement and the livestock have access to pasture during the grazing period.

3. Open air areas may be partially covered.

(EC) 834/2007 Art. 14(1)(b)(iii)
(EC) 889/2008 Art. 10(4); Art. 14(1)(3); Annex III

Breeding

Breeds are selected for end product purposes as well as production ease (e.g. lambing ease, maternal abilities etc.), and environmental adaptability. Breeds may also be selected for disease traits such as tolerance or even resistance to worms. Careful crossbreeding can be used to aid carcass confirmation and growth rate of lambs or increase maternal abilities for replacements. Conservation of the biodiversity of animal breeds is an important condition for animal production to adapt to future changes. Forage conversion is also important in organic systems as most of their diet comes from grass. More detail on specific breeding strategies, characteristics, genetics and breeds for organic sheep systems can be found in Chapter Breeding.

1.3.4. Goats

In 2019, Europe was home to 1.9% of the world goat population and produced 5.1% of the goat milk recorded worldwide. Organic goat milk production is on the rise, increasing by 47.2% in the period from 2012 to 2017. When comparing the growth rates of organic milk and organic meat production, milk showed strong growth rates. There are many different methods of goat breeding, and many species are well adapted to grazing a range of rangeland-based ecosystems. This allows farmers to switch to organic products without major operational changes.

Nutrition and Feeding

Feeding goats organically requires maximum utilisation of grazing pasture. At least 60% of the daily nutritional requirements of goats (based on dry matter) should consist of fresh or dry feed. silage of roughage, with the exception of periods when animals are under transhumance. This is calculated on a dry matter basis. Guidance on daily dry matter intake for goats can be found in Table 7. In total, at least 60% of their annual diet must come from the farm to maintain organic status. Where this is not possible, off-farm feed must come from local organic producers within the area. For goats producing organic milk, a reduction to 50% of their diet to be fresh or dried fodder during the early stages of lactation is acceptable. This period can last a maximum of 3 months. Organic dairy systems may experience a lower milk yield than conventional systems, but their product can be classified as higher quality.

Allowing animals these minimum standards as well as access to outdoor grazing results in high animal welfare and allows animals to exhibit natural behaviours, reducing stress and disease within the herd. Exceptions are made during transhumance and where catastrophic circumstances occur (infectious disease outbreaks, contamination of feedstuff with toxic substances, exceptional weather conditions and fire.

Young Stock

The feeding of kids falls under the same regulations, minimum periods and restrictions as that of lambs. See section 1.2.3.

Animal Health

An animal health plan must be in place which is produced with the farmer or food producer's veterinary surgeon as part of the conversion plan and must be in place prior to conversion to organic. Animals must be treated as required (with necessary products), but using the health plan, this process is more formalised. Withdrawal periods apply and are either doubled or trebled to achieve organic compliance (see Chapter Food Safety, section 3.2. Medicine Residues within Organic Derogations).

Specific health problems which may occur in both meat and dairy goats are similar to those of sheep (see section 1.2.3.). It has been suggested that an increase in protein levels in organic goats' diets, can assist in improving resilience and/or resistance to internal parasites. An increase in protein levels boosts the immune system and increases production efficiency. Breeding strategies to combat animal health related issues in organic systems are discussed in Chapter Breeding.

Animal Welfare

Animal welfare is very similar to that for sheep. See section 1.2.3.

Housing

Housing is not essential where the climate and soil type in the area is appropriate for outdoor living all year round. However, shelter must be available in some form whether natural or artificial. Where housing is required, it must provide adequate insulation, ventilation and heating to provide that temperature, humidity, air circulation, dust levels and gas concentration are kept within non-toxic limits.

Stocking densities in organic systems generally allow more space than conventional farming systems. There are minimum standards in terms of flooring space for goats in organic systems. Specific details can be found in table 8.

Breeding

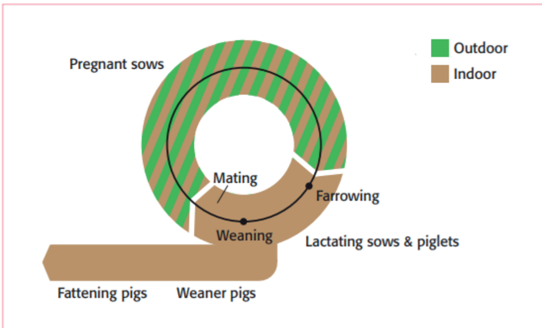
Breeds are selected for end-product purpose as well as production ease (e.g. kidding ease, maternal abilities etc) and environmental adaptability. Breeds may also be selected for disease traits such as tolerance or even resistance to worms.

Careful crossbreeding can be used to improve carcass confirmation and growth rates of meat kids, or to increase milk yield for milking goats. Conservation of the biodiversity of animal breeds is an important condition for animal production to adapt to future changes. More detail on specific breeding strategies, characteristics, genetics and breeds for organic goat systems can be found in Chapter Breeding.

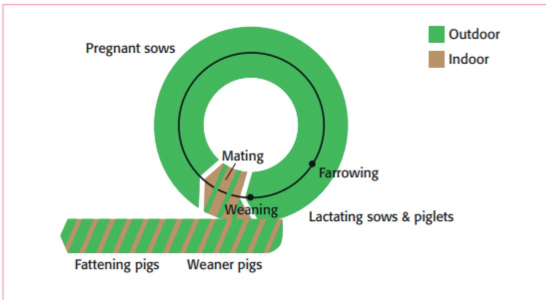
1.3.5. Pigs

As with the other mammal species, organic pig production in Europe is on the rise. Due to variations in climate, topology, soil characteristics, farming practices and local vs national organic schemes, organic pig production varies across Europe. There are three main types of organic pig farming, indoor with outdoor pen, outdoor all year round and a mixture of the two. Examples of how they differ can be seen in figure 1. There are advantages and disadvantages to both systems, so careful planning and decision making needs to occur during conversion.

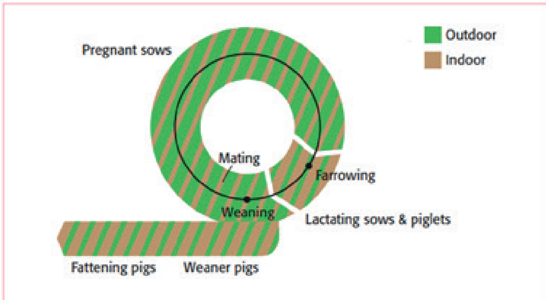
Figure 1. Different housing period for indoor and outdoor organic pig systems



Indoor system, where sows have access to an outdoor run when not lactating



Outdoor system, where sows are housed for mating and piglets housed for weaning and fattening



Mixed system, where the advantages of both systems can be utilised accordingly

Nutrition and Feeding

As mentioned above, organic pig production is quite diverse. Some sows spend all their time outdoors, some are brought in during lactation and some use a mixture of the two methods, depending on the time of year, pasture availability etc. Regardless of where the animals are housed, fresh fodder, dried fodder and roughage must be fed at all production stages. Silage can also be added to their everyday ration. At least 60% of their diet must be grass based either fresh, dried fodder roughage or silage. This is based on their dry matter intake. Guidance on daily dry matter intake for goats can be found in Table 9.

Table 9. Guidance table on daily dry matter intake (DMI) for Pigs

Category	Daily DMI (kg)
Sow and 6 piglets	4.50
Each additional piglet	0.40
Gilts	2.60
Weaners at 9 weeks	1.00
Weaners at 25 weeks	2.65

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For organic pig systems, a minimum of 20% of their total ration must come from the farm where the pigs are reared. Where this is not possible, off-farm feed from local organic producers or feed operators is allowed. Where animals have the ability to graze and forage on pasture, no additional feed needs to be added.

Where animals are fed ad lib they must be feed in a way which ensures that bullying and conflict do not occur. This means adequate feed space must be given to provide that all animals can feed at the same time, which will reduce any aggression or conflict over food. For pigs that are not fed ad lib, the following guidelines should provide adequate space when fed rationed feed:

- ✓ 5 kg pig = 10 cm trough space.
- ✓ 10 kg pig = 13 cm trough space.
- ✓ 15 kg pig = 15 cm trough space.
- ✓ 35 kg pig = 20 cm trough space.
- ✓ 60 kg pig = 23 cm trough space.
- ✓ 90 kg pig = 28 cm trough space.
- ✓ 120 kg pig = 130 cm trough space.

Positioning of water troughs must also be considered to avoid unnecessary conflict. Where troughs are used, allow 30 cm of trough length per 10 pigs. Where nipple drinkers are used, there should be one drinker per ten pigs. These drinkers should also have minimum flow rates to avoid further competition. See table 10 for details.

Table 10. Minimum flow rates for nipple drinkers in organic pig systems

Weight of pig (kg)	Flow rate (ml/min)
Newly weaned	300
Up to 20 kg	500-1000
20 kg-40 kg	1000-1500
Finishing pigs up to 100 kg	1000-1500
Sows and gilts – pre-service and in-pig	2000
Sows and gilts – in lactation	2000
Boars	2000

Allowing animals these minimum standards as well as access to outdoor grazing results in high animal welfare and allows animals to exhibit natural behaviours, reducing stress and disease within the herd. Exceptions are made during transhumance and where catastrophic circumstances occur (infectious disease outbreaks, contamination of feedstuff with toxic substances, exceptional weather conditions and fire).

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Young Stock

Pigs reared in organic systems are weaned much later than on conventional pig units. Organic pigs are weaned at 40 days rather than as early as 21 days. Allowing pigs, a minimum of 8 weeks before weaning allows the animal to develop at a natural pace, reducing stress, disease and should reduce any antibiotic use.

Milk fed must be natural, such as organic milk, preferably their own maternal milk. Maternal milk is that of the young animal's mother. Natural milk is defined as that of the glands of an animal. Natural milk from another species can be fed providing it meets the nutritional needs and health requirements of the species it is being fed too. Organic milk and milk products are only classified as "organic" providing they have been under continuous organic management for a minimum of one year. Milk powder is classified as a natural source of milk, providing it only contains milk powder and no additives. Organic farmers must have an emergency plan in place for a source of organic colostrum which should be specified in the health plan. In an emergency, non-organic milk replacer can be fed to young animals for up to 72 hours. If this is used after 72 hours the animal is no longer classified as organic. Piglets receive milk until they are at least 40 days old and are allowed access to pasture for grazing in the warmer months. Once weaned they need to be housed in groups of similar aged piglets to avoid unnecessary stress. Weaners must have access to both an indoor and outdoor areas, with a warm bedded environment, spacious enough to prevent fighting. Weaners should be kept in their own litters where possible. Piglets may not be kept on flat decks or in piglet cages.

Animal Health

An animal health plan must be in place which is produced with the farmer or food producer's veterinary surgeon as part of the conversion plan. It must be in place prior to conversion to organic. Animals are treated for disease and injury as required (with appropriate products), but using the health plan, this process is more formalised. Withdrawal periods apply and are either doubled or trebled to achieve organic compliance (see Chapter Food Safety, section 3.2. Medicine Residues within Organic Derogations). Where justification occurs in the Animal Health Plan on the grounds of animal welfare, veterinary treatments, licensed for the purpose, can be used to treat the following external parasites:

- ✓ Biting flies, lice, ticks, etc.: the use of synthetic pyrethroid insecticides as a topical treatment.
- ✓ Mange and warble flies - Ivermectin as an injection.

Pour-on treatments should be avoided if possible due to the concentrated nature of the chemical.

In non-organic pig systems, the majority undergo mutilations such as tail docking and teeth cutting to avoid injury during rearing. As most conventional pigs are farmed indoors,

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dominant behaviours like fighting occur regularly, therefore these mutilations are necessary to avoid injury and/or death. For example, around 80% of conventionally reared UK pigs have their tails cut off to prevent tail biting. In organic pig systems, these mutilations are prohibited. Most organic pig farms will be outdoors, decreasing the likelihood of fighting as all animals should have access to enough space to remove the need for aggressive behaviours.

Where animals are housed outdoors, animal health is influenced more by climatic conditions, exposure to parasites etc. As with the methods described in section 1.2.3. Sheep, parasite infection should be avoided by appropriate management methods such as rotational grazing, which can also be used to maximise vegetation regrowth and avoid outdoor pasture turning to muddy puddles which reduces exposure risk to parasite and bacterial build up in the damp environment. Breeding strategies to combat animal health related issues in organic systems are discussed in Chapter Breeding.

Animal Welfare

Like all organic farming systems, the aim is to allow animals the "most natural" experience whilst on the farm. In terms of pigs, this would be access to open pasture, as well as being allowed to remain in their family groups. In all organic pig farms, a rooting and dunging areas must be provided. These must be outdoor and adequate rooting substrates must be provided for use at the animal's leisure. Examples of rooting materials include straw, seeds, green fodder (such as grass, hay, silage) and wood shavings. Pigs do not favour rooting in dung covered areas, therefore these "rooting areas" must be cleaned regularly to remove any dung. Frequent replacement with new substrates will encourage regular rooting with their snouts.

Housing

Housing is not essential where the climate and soil type in the area is appropriate for outdoor living all year round. However, shelter must be available in some form, whether natural or artificial. Where housing is required, it must provide adequate insulation, ventilation and heating to provide that temperature, humidity, air circulation, dust levels and gas concentration are kept within non-toxic limits. It is recommended that pigs should not return to the same ground more than 1 year in four, or spend more than 6 months on the same parcel of land.

As mentioned earlier, organic pig farms are very diverse with fully outdoors, sows housed during lactation, and a mixture of both systems being adopted across Europe. In organic systems, where pigs are housed indoors, access to an outdoor run must be available. This allows animals to experience climatic influences and express natural behaviours (See figure 2). This differs to animal housing provided for animals kept outdoors all year round (See figure 3).

Figure 2. Outdoor run attached to an indoor organic pig house

Figure 3. Houses used for outdoor organic pig system

For animals housed or outdoors, heat and cold stress are of specific concern for organic pig systems. Heat stress can be detrimental for lactating sows, whereas dry sows will be more susceptible to cold stress due to their restricted feed intake. Wallows and shade must be provided during the summer. Therefore, careful monitoring and environmental set-ups are required, dependant on where the animal is in its breeding cycle.

Stocking densities in organic systems generally allow more space than conventional farming systems. There are minimum standards in terms of flooring space for pigs in organic systems. Specific details can be found in table 11.

Table 11. Minimum housing area for pigs in organic systems

Class of animal	Lying area or indoor area m^2 per head	Outdoor exercise area required m^2 per head (Excluding pasture)	Total m^2 per head
Farrowing sows with piglets up to 40 days	7.5	2.5	10
Piglets Over 40 days and up to 30 kg	0.6	0.4	1.0
Fattening pigs			
Up to 50 kg	0.8	0.6	1.4
Up to 85 kg	1.1	0.8	1.9
Up to 110 kg	1.3	1.0	2.3
Breeding pigs			
Sows	2.5	1.9	4.9
Boars	6 If pens are used for natural service: 10m²/boar	8.0	14 If pens are used for natural service: 18 m²/boar
2. Open air areas may be partially covered. *(EC) 889/2008 Art. 10(4); Art. 14(1)(3); Annex III*			

Where animals are housed, appropriate stocking densities must provide comfort and wellbeing of the animals. Body marks and lesions on pigs could be a sign that the stocking densities are inadequate. Where wounds on the heads and shoulders appear, a clear lack of space to demonstrate natural social ranking is occurring. In these circumstances, stocking densities need to be assessed and increased to avoid further injury. Providing adequate space will allow pigs to display submissive behaviour such as dispersal during fights, reducing the frequency of wounds, bite marks of lesions occurring.

Breeding

Where housing occurs in pigs, sows must be kept in groups. If animals are reared in groups, the size of the group should depend on the developmental stage of the animals and the behavioral requirements of the species concerned. In the final stages of pregnancy and during suckling the farmer may choose to keep sows and their litters separate. In organic systems some types of housing are prohibited, including the use of farrowing crates for sows. This goes against the requirements for space set out in section 1.2.4. Piglets are not allowed to be kept in cages or on flat decks in organic systems. More detail on specific breeding strategies, characteristics, genetics and breeds for organic pig systems can be found in chapter Breeding.

1.3.6. Keeping Non-Organic Livestock and Organic Livestock

It is permitted to have organic and non-organic livestock on the same holding providing they meet the following criteria.

- ✓ The organic and non-organic animals must be different species.
- ✓ They must also be kept on different parcels of land and clearly in separation.
- ✓ Where animals are housed, organic and non-organic animals must be kept in different buildings.

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- ✓ Records must be kept detailing separation of the organic and non-organic animals.
- ✓ Non-organic animals can be grazed on organic pasture providing organic animals to not graze at the same time and low stocking densities are maintained (max stocking rate equivalent to 170 kg of nitrogen per hectare in a year).

2. Regulatory Considerations for Organic Farming

For farmer and food processors to become certified, they must go through a conversion process, which can take up to 3 years depending on the system. Application is made to a national accredited certification body and a certification contract is put in place. See Chapter Food Safety, section 2.1. Certification for full details.

Once certified, the farm will be regularly inspected to ensure compliance. Farmers and food producers must comply with all relevant organic standards within their farm business. Further details of inspections can be found in Chapter Food Safety, section 2.3. Inspections.

To demonstrate compliance, record keeping is essential in both the conversion period and afterwards. Because organic food and farming is defined by EU and national law, it is a government requirement that the relevant organic standards are met. Record keeping requirements cover all aspects of the farming operation, which acts as proof that the product has been created in accordance with organic standards and legislation. These records must contain information on all production activities, as well as all products bought in to the farm, as well as products sold or dispatched. This is also a method of monitoring outputs and inputs. It can also be used to monitor procedures and animal health related activities, again to ensure they comply with the relevant organic standards. See Chapter Food Safety, section 3.1. Record Keeping for more details. This section contains details on all the records needed, including those associated with Livestock Production (Chapter Food Safety, section 3.1.3.), Plant Production (Chapter Food Safety, section 3.1.2.), Feed Records (Chapter Food Safety, section 3.1.4.), Veterinary Records use (Chapter Food Safety, section 3.1.5.) and Other Records (Chapter Food Safety, section 3.1.6.) which need to be kept.

Details of cleaning control records can be found in Chapter Food Safety, section 3.4. Cleaning. Acceptable chemicals and the processes associated with their use in organic systems can be found in this section too. Details of pest control records can be found in Chapter Food Safety, section 3.4.2. Cleaning – Pest Control. Details of transport records can be found in Chapter Food Safety, section 4.1. Transport.

3. Economic Considerations for Organic Systems

The potential additional costs and risks associated with the change to organic farming need to be considered by farmers who are thinking about converting to organic.

Changing a farm from conventional to organic takes time to implement, and requires consideration of the practical implications, and an analysis of the financial risks and benefits involved. Not only will there be a change required in the physical management of the farm, but the marketing and financial implications must also be considered.

Farmers convert their holdings to organic for a range of reasons. For some it is a purely commercial decision, driven by marketing opportunities and relative profitability. For others, the decision is, in part at least, made for more philosophical reasons, and a need to farm in a way which is more in harmony with nature.

Whilst most farmers complain about the paperwork they are required to complete, the fact that organic food and farming is legally defined means that they are protected from unfair competition – food is either legally organic, or it is not. It is the only food production system which is legally defined from farm to consumer.

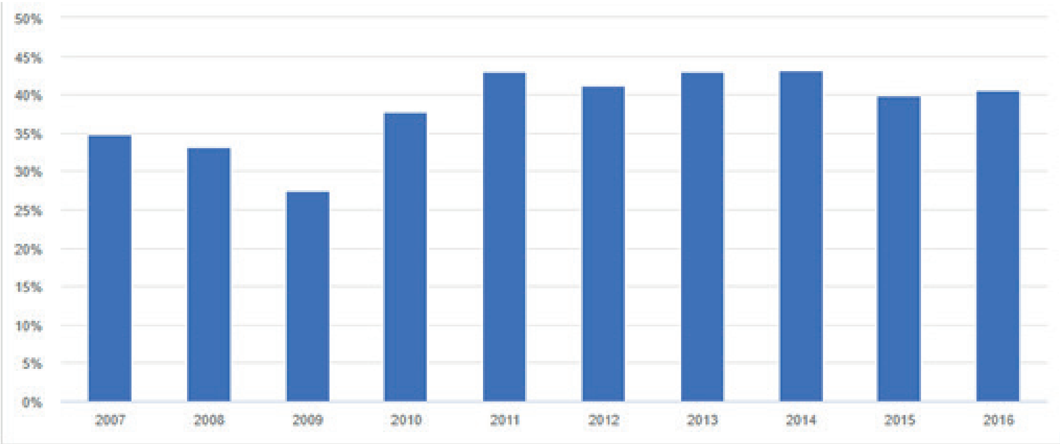
The advantages and disadvantages of organic farming compared to conventional farming are summarised in table 12.

Table 12. A summary of the pros and cons for organic systems when comparing them to conventional systems.

Advantages	Disadvantages
Produces healthier food	Significant costs, especially at the beginning
Improvement in human health	Pest issues as chemicals restricted
Actively improves soil health	High regulatory standards (not achievable by all)
Avoids pollution (soil, ground water)	May not be suitable for mass production
More sustainable	High certification costs
Protects nature (insects, birds, wildlife)	Final products too expensive, niche market
Organic waste can be composted & reused	Time consuming methods used
No use of GMOs	Not achievable for small businesses?
Better for the planet (climate change)	High amount of knowledge required
More traditional/natural form of farming	High variance in yield and quality of product – food security issues
Better for farmers health (mental, physical)	
Pollination may be easier	
Organic food tastes better	

All farmers can apply for income support under the Common Agricultural Policy (CAP). This is usually calculated on a farm size basis (in hectares) and is given to all farmers due to low wages, risks and return lag times associated with farming as a livelihood (table 13).

Table 13. Farm income per family worker compared to wider wages in the economy



Further payments are available (in all EU Member States), such as financial support for those undergoing conversion and for maintaining organic status. This demonstrates a recognition of the benefits for society, nature and the environment that come from organic farming. In addition, greening payments may be available to further assist with conversion and maintaining organic systems. Farmers are not only managing the countryside, but they are stewards of our natural resources as well. These "greening" payments are specific payments associated with encouraging farmers to make environmentally beneficial decisions. All EU countries allocate 30% of their income support to "greening", demonstrating the importance of protecting the environment. These payments are also automatic to further reflect the intrinsic environmental benefits associated with organic farming and its principles. There are also agri-environmental schemes aimed at promoting public goods within farming and providing farmers financially for investing in these. These schemes have been shown to be successful in changing farmers attitudes and behaviours. Some support may also be available for organic farmers during conversion for changes to infrastructure for example grants for machinery or building restructure. However, these are usually only available during the conversion period, therefore not a long-term resource during financial planning.

4. Environment Considerations for Organic Systems

In a world where we are becoming more aware of climate change, protecting our environment and a higher focus on healthier diets, it is not surprising that organic farming is on the rise.

Organic farming aims to work in harmony with nature, as its major principles focus on environmental and natural gains. Organic producers must develop a Farm Biodiversity and Conservation Plan that details the farm policy for managing the farm environment. For this purpose OF&G Registration Form 1 – can be used – "Farm Biodiversity and Conservation Plan". A protection plan for another responsible control body is acceptable. In addition, a Farm

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Waste Management Plan in line with the Codes of Practice for the Protection of Soil, Air and Water must be in place.

Nature friendly land-use practices such as maintenance of hedgerows, woodlands and ponds, minimises disruption to the natural environment, protecting sensitive habitats and protecting biodiversity.

Prohibited use of fertilisers, pesticides and chemicals benefits the environment by reducing pollution to both the water, air and soil, as well as producing a healthier product with few, if any additives compared with conventional farming. Direct and indirect pesticide and insecticide use has contributed to the global decline of insects. It is said that insects are most at risk with their decline being 8 times faster than that of mammals, birds and reptiles, which could be associated with widespread pesticide (and insecticide) use both directly and indirectly. Unlike intensive farming, organic farming only uses management practices which benefit the environment, animals, nature and society.

Protection of wildlife and provision of appropriate habitats is critical to the survival of many species. Organic farming practices work to promote species richness by providing a range of habitats for a multitude of fauna and flora which can be seen when measuring biodiversity. On average, plant, insect and bird lifespans are up to 50% longer on organic farms.

Crop diversity also help reduce the risks associated with growing single crops, so in some ways the investment in organic farming aids financial stability by removing this risk. For optimal animal health, temporary pastures for grazing and forage production should ideally have a wide variety of species through the inclusion of mixed grasses, alfalfa and plant varieties. It also makes agricultural systems more resilient to climate change.

Organic farming also contributes to increasing (and maintaining) soil fertility, biodiversity (both above and below ground) and soil stability. Almost 95% of our food production is dependent on the soil (UN Food and Agriculture Organisation (2015), meaning that healthy soils are critical to our existence. Healthy soils also help prevent flooding and drought, suggesting that organic farms are even more resilient to climate change.

Management methods such as crop diversification, maintaining permanent grassland (for diversity, habitat maintenance and carbon sequestration) as well as allocating areas of their arable land to ecological focus areas (EFA) are all practices dedicated to 'greening', which occur more widely in organic systems. These methods increase overall soil health, which increases carbon sequestration, helping to build soil carbon in organic farmland (see figure 4).

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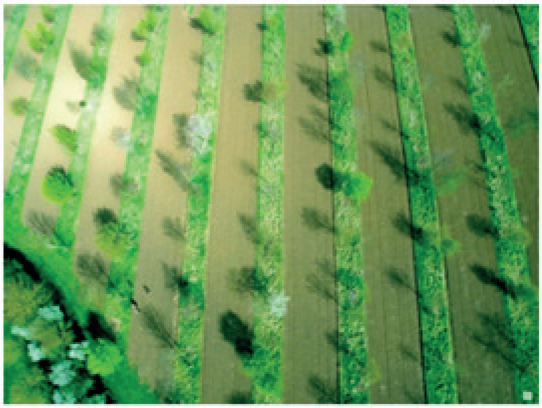
Figure 4. Examples of unprotected soils compared with those undergoing agri-environmental systems



Left: Unprotected, uncovered soils allowing erosion during extreme weather conditions. Right: Practices such as hedge planting (agri-environmental scheme) aiding to protect soil from runoff, soil erosion and covering the land with a canopy, as well as providing nitrogen fixing and carbon sequestration properties.

"When evaluated over the long term, organic soils are about 25% more productive for carbon storage conditions and increase by an average of 2.2% per year after soil carbon becomes organic." which equates to 3.5 tonnes per hectare of additional carbon sequestration.

In some areas of Europe, grazing ruminants are being used actively to provide a public service in the form of preventing wildfires.

Areas of France and Spain are generating additional value of their grazing livestock, by using sheep and goats directly to reduce biomass fuel in areas where traditional mechanical methods to remove scrub and undergrowth is inaccessible. It is also cheaper and better for the environment as fossil fuels are not being burnt.

Other management methods within organic farming are aiming to maintain soil health and avoid soil damage when grazing livestock exist, for example reducing or removing livestock when soils are wet, moving feeders and troughs at systematic intervals (or installing hard standing to prevent soil damage), restricting access to wet areas, avoiding heavy machinery use and moving livestock to fresh pastures regularly. These methods will all reduce soil compaction, overgrazing and poaching which other farming method may experience.

In addition to direct environmental benefits, organic systems are better at recycling ecological materials and include use of more renewable energy sources. As mentioned earlier, organic farming aims to be self-sufficient or use local resources, resulting in lower food miles and lower energy use. By relying on natural predators and fertilisers which are produced on-farm or locally, greenhouse gases are reduced in organic farming systems. Most organic livestock is fed from home-grown or locally-sourced feed and cannot contain GM components.

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Conventional animal feeds usually contain products which are imported, which adds to greenhouse gas emissions compared to organic systems. It was said that if all of Europe's farmland was managed according to organic principles, agricultural emissions could fall by 40-50% by 2050.

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UNIT 10:

FOOD SAFETY

INTRODUCTION

In a world where we are becoming more aware of climate change, experiencing a worldwide decline in wildlife and major diet related health issues, there has never been a greater demand for “agroecological farming” or “holistic farming” which works in harmony with nature. The principles of organic farming aim to achieve that.

What is the term organic? Organic can often be confusing for both the producer and the consumer. The fundamental principles of organic farming are built on the mantra healthy soils results in healthy crops, healthy livestock, healthy people and a healthy planet. Organic farming uses farm management and food production practices which combine the best environmental and climate action techniques, incorporate a high level of biodiversity and high animal welfare whilst preserving natural resources such as soil fertility and water quality. To achieve this, organic farmers and food producers must comply with a set of strict EU regulations delivering high production standards. As a result, organic produce is seen as healthier as it is virtually free from additives and does not contain any Genetically Modified Organisms (GMO). In addition, management practices allow a reduced use of fertilisers, pesticides, herbicides, and insecticides and those that are used meet strict organic criteria or are natural in composition. Animal welfare standards in organic farming are a high priority.

Consumers are becoming more aware of not only where their food comes from, but how it has been produced, creating further demands in food production. People want healthier foods, produced under high welfare standards and to high production standards, and free from as many chemicals as possible. Organic farming can meet these consumer demands, assisting to increase food safety and overall human health.

1. Why is food safety important?

Food safety can be defined loosely as food that when consumed does not make you ill. There are several different aspects of the term food "safety", such as considering the nutrition of food, the integrity of the product as well as transparency within the supply chain. These are all areas where food safety needs to be considered. Further details of areas for food safety concern are listed in table 1.

Table 1. A broad food safety definition

FOOD SAFETY	
Product safety[1]	**Agri-food-system safety**
• Safety, non-toxicity of the food • Safety, nutritious food • Safety of the declaration (all components of the food are shown on a declaration) • Safety of the label (the organic food is truly organic)	• Safety of supply • Safety of distribution • Safety of transparency and proximity • Safety of consumer influence on food production • Safety of information on the whole food production process (e.g. by using labels) • Safety, no negative impacts of production practices on humans and other living organisms, the environment, climate etc.

[1]: The traditional definition (e.g. given by the Danish authorities: [21])

Food safety is extremely important in all areas of farming and food production to ensure high levels of public safety. It is vitally important to ensure consumers are protected from food-borne illnesses and food poisoning. Consumers have the right to know where and how their food is produced, processed, packaged, labelled and sold, a view shared by the EU Commission. Without trust in the supply chain, consumer confidence would be shattered, which has been shown to change buying behaviours and reduce consumption. As well as causing suffering in humans, there is also the economic losses to food production and the food industry to consider.

In order to manage food safety, the EU implemented the integrated Food Safety Policy, which covers 4 main areas of food safety. These are Food Hygiene, Animal Health, Plant Health, and Contaminants and Residues. Within these main categories the priority actions are:

- ✓ To ensure substantial control systems and evaluate compliance with EU standards in all areas of food safety (e.g., food quality, animal health and welfare and nutrition). This is also the case for any non-EU countries in relation to any exports to the EU.
- ✓ To manage international relations with non-EU countries and international organisations where food safety is concerned.
- ✓ To manage relations with the European Food Safety Authority (EFSA) and ensure risk management occurs through science-based advice.

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1.1. Zoonoses

Zoonotic diseases (zoonoses) are disease or infections that can transfer between animals and humans resulting in illness. They can transfer either directly or indirectly. Zoonoses can be caused by bacteria, viruses, parasites and fungi all of which can be referred to as zoonotic agents. Contamination by these zoonotic agents results in varying illness ranging from mild to severe. Some can even result in death. It is estimated that 60% of known infections and 75% of emerging infectious diseases in people spread from animals. Zoonoses can occur through direct contact such as saliva, blood, faeces, bodily fluids and through indirect contact such as objects in animals' environment, bedding, aquarium tank water. They can also be vector-borne (tick, insect, mosquito bite), foodborne (eating contaminated food) and waterborne. There is also the risk that any contact with wild animals or pets may result in spreading the infection.

Legislation on communicable diseases in the EU has only existed since 1998, before which a simple directive was in place. Cooperation between member states on the control, surveillance and monitoring of zoonotic diseases was implemented and guidelines set up to ensure consistency across Europe. In 2003, a further directive was published, focusing exclusively on zoonotic diseases, describing how data on the occurrence of zoonoses and zoonotic agents in animals and feed should be collected to determine trends and potential sources of zoonoses in Europe. The decision was also made to make this an annual occurrence.

To comply with EU regulations there are 8 mandatory zoonotic diseases which must legally be reported if they occur. These are Salmonella, Campylobacter, Listeria monocytogenes, Shiga toxin-producing Escherichia coli (STEC), Mycobacterium bovis, Brucella, Trichinella and Echinococcus. There are other zoonotic agents which must be monitored dependant on epidemiological status, shown in figure 1.

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Figure 1. Details of zoonotic agents which must be monitored dependant on epidemiological status

1. *Viral zoonoses*
   - calicivirus
   - hepatitis A virus
   - influenza virus
   - rabies
   - viruses transmitted by arthropods
2. *Bacterial zoonoses*
   - borreliosis and agents thereof
   - botulism and agents thereof
   - leptospirosis and agents thereof
   - psittacosis and agents thereof
   - tuberculosis other than in point A
   - vibriosis and agents thereof
   - yersiniosis and agents thereof
3. *Parasitic zoonoses*
   - anisakiasis and agents thereof
   - cryptosporidiosis and agents thereof
   - cysticercosis and agents thereof
   - toxoplasmosis and agents thereof
4. *Other zoonoses and zoonotic agents*

Cases of zoonotic disease vary year on year, but bacterial related illnesses seem to be most prominent. For example, in 2020, Campylobacteria was the most commonly reported zoonotic illness, followed by other bacterial diseases (see figure 2 for specific details).

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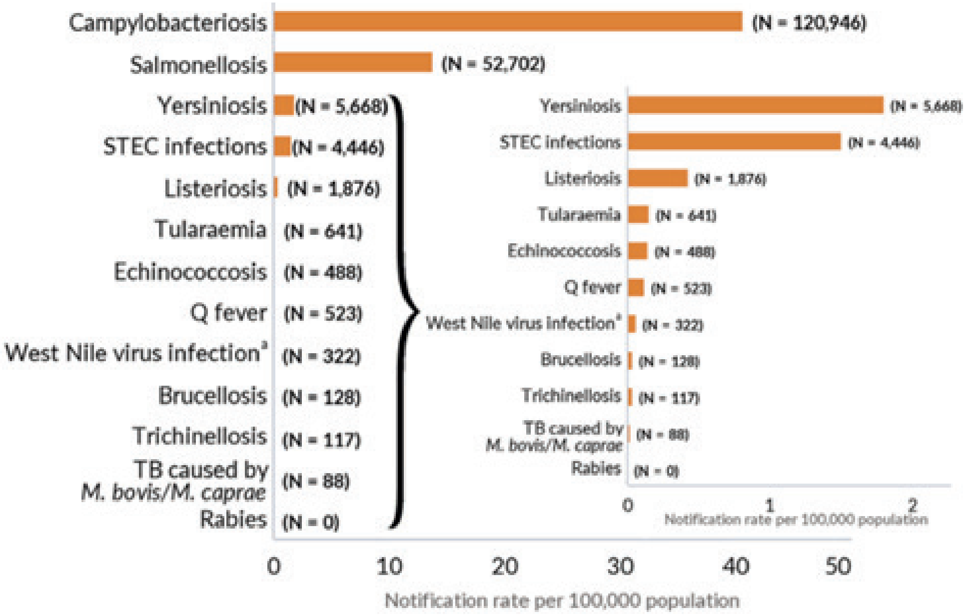
Figure 2. Reported numbers of cases and notification rates of confirmed human zoonoses in the EU, 2020



Note: The total number of confirmed cases is indicated in parentheses at the end of each bar.
(a): Regarding West Nile virus infection, the total number of cases was used (includes probable and confirmed cases).

There are many factors that increase the risk of infection such as characteristics of human host population (population density, age, affluence), human behaviour, political issues (war, state of public health services and veterinary services available, political instability), economic issues (development, travel), climate and ecology, developments in animal health as well as direct risk factors with the zoonotic agent themselves such as microbiological adaptation and selection. There are also concerns that with continuous changes to our environment, in combination with increasing movement and globalisation, alongside increased contact between humans, wildlife and domestic animals, new zoonotic agents are going to occur, as well as known zoonotic agents invading new geographical areas or re-emerging in areas previously clear.

In order to control the emergence of disease and infection, farmers and food producers need to consider reducing the risk of contamination during the whole production process.

1.2. Reducing the Risks in Organic Systems

As part of organic compliance, the farmer and food producers must state if there are any contamination risks to their products and state how they will reduce any risks of contamination to the organic product by unjustified or forbidden substances. Any risks identified and measures taken to decrease the risk must be documented, acting as evidence within their records (see section 3.1. Record Keeping for further detail).

Risks within the whole production chain must be accounted for including production, processing, transport, packaging, and storage. Efficiency of any risk reducing measures and continued monitoring of efficiency must also be documented. Monitoring occurs both at a primary production level, as well as in other stages of the food chain, which in livestock farming includes animal feed.

It could be argued that organic farming systems decrease the risks associated with zoonosis in comparison to factory farming due to the main organic principles. Organic systems in general are more extensive and aim to reduce the period animals are housed, if at all. Should they be housed, more space is provided than in conventional systems, therefore crowding and direct animal to animal contact is reduced, reducing the risk of infections spreading due to overcrowding/close quarters. Hygiene and cleanliness standards are higher in organic systems, further reducing the risk of zoonosis. In addition, pesticides, fertilisers, chemicals and veterinary products are used more widely in conventional systems than organics, meaning antimicrobial resistance and resistance to their effectiveness will be higher in these systems than in organic systems. Therefore, it would seem that organic systems should be more resilient and resistance to disease outbreaks based on their principles and husbandry practices. However, it could be argued that due to organic husbandry increasing time spent outdoors, there may be increased exposure external contaminants such as wild animals, which need to be considered when assessing the risk of infection.

1.2.1. Genetically Modified Organisms (GMO)

One of the specific regulations with regards to organic farming and food production is the absence of GMO in organic products. All animals farmed organically are fed on natural organic diets and any grains or concentrate feed used must be completely GM-free. The same goes for derivatives of GMOs, these cannot be used in organic systems. Adequate record keeping must demonstrate that any bought-in products (such as feed, fertilisers, seeds etc.) do not contain any GMO material or their derivatives and meet organic standards. There must also be considerations and risk management strategies in place to avoid contamination from GM containing materials such as feed, pesticides, herbicides, manure, fertilisers etc. (see section 3.3. Pesticide, Herbicide and Fertiliser Residues with Organic Derogations). Where products consist of or are made of GMOs, these cannot be labelled as organic. Products that don't specifically state GMO free cannot be used in organic systems without a confirmation letter from the supplier confirming they are GMO free. GMOs are classified in the organic regulation as 'excluded methods' and are forbidden.

1.3. Consumer Confidence

As discussed above, human health is the upmost importance in food production. Alongside this, consumer confidence is key to securing consumption. Over the past decades, the public have become more concerned over food safety due to outbreaks such as BSE, increased occurrence of Salmonella in eggs and meat, increased occurrence of Campylobacter in meat and findings of Listeria in some dairy products. This has led to consumers opting for organic products over conventionally farmed alternative as the husbandry practices for production are much more environmentally friendly, considered more natural and are produced with fewer external inputs. It is widely known that many externally sourced inputs are prohibited in organic farming, husbandry practices are higher, artificial nitrogen fertiliser applications are banned, and withdrawal periods for prophylactic treatments are longer, ultimately leading to an end-product that contains fewer artificial substances. The Soil Association states that in 2017 and 2018, over a quarter of all food items tested by government authorities in the UK contained one or more pesticide. This included more than half of rice, a quarter of bread and 40% of fruit and vegetables. There are direct public concerns over the increased occurrence of dioxins in food and feed, excessive amounts of pesticides, antibiotics, additives, etc. in food, and the presence of toxic fungi in stored foods. Even when food is washed and cooked, there may still be exposure to pesticides. Therefore, the public are opting for organic products as a method of reducing any exposure to herbicides, pesticides and other additives. Organic certification and labelling are agreed nationally and across Europe, with independent inspectors, increasing consumer confidence in organic products (see section 4.3. Labelling and Traceability). This ensures that organic certification and labelling guarantees food quality from sustainable farming practices with a more traceable production process.

In addition to public interest increasing in the organic sector, political changes such as the reform of CAP of the EU (1992) which focused on the importance of the protection of the environment, improved animal welfare and sustainable rural development, demonstrates further acknowledgement that farming practices working in harmony with nature are viewed more favourably by the public.

There is also the perception that organic food is better for you, not only due to the reduction or artificial products being allowed during production, but as the animals have led a more extensive, outdoor lifestyle, with improved standards of living, the end product should be higher in quality. Further research is required to confirm direct nutritional benefits of organic products but the factors contributing to increased quality in organic production are summarised in figure 3.

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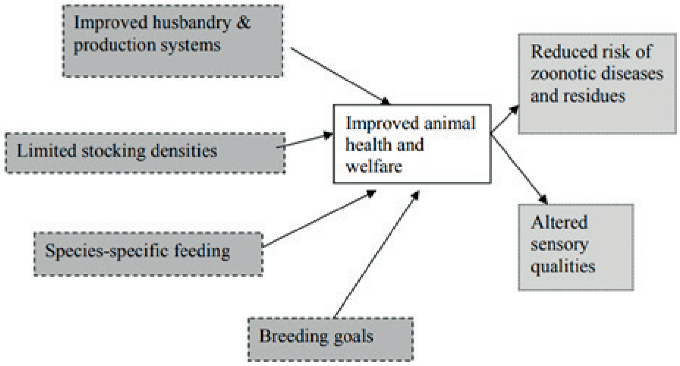
Figure 3. Summary of the factors affecting animal health and welfare, which link directly to product quality in organic systems



Some detailed analyses of organic husbandry and management methods have been conducted, that demonstrate their positive effect on product quality. These are summarised in table 2.

Table 2. Summary of the potential impact of organic husbandry practices on product quality and process quality

Principle	*Process* quality: potential impact	*Product* quality: Potential impact
Self-sufficiency, land-based production, integration of crop and livestock production	- Local resource use: impact on local economy - Limited environmental impact - Risk of local soil deficiencies being manifested	- Product composition could be influenced by local conditions; e.g. local soil deficiencies - Local conditions could affect the sensory quality of the product - Potential contamination of home-grown feed by mycotoxins
Limited stocking density	- Less pressure on land: better conditions for good health and welfare management (no poaching, good evasive grazing systems for parasite control etc.) - Limited environmental impact	- Potentially altered sensory quality of products
Loose hosing and/or outdoor life	- Animals have access to natural behaviour and social contact with other stock - Naturalness of the system	- Potentially altered sensory quality of products - Potential risk from zoonoses from contact with wildlife and other livestock
Species-specific feeding	- Naturalness of system - Harmony between animals and system - Decreased disease risk from system-related diseases, such as weaning diarrhoea in pigs, acidosis in ruminants etc.	- Altered sensory and nutritional quality as a result of slower growth rates and forage based diets
Use of suitable breeds	- Harmony between system and the animals	- Potentially altered sensory and compositional quality of product
Limited veterinary medicinal inputs	- Potentially increased risk of suffering if conditions are not treated - Increased focus on disease avoidance	- Reduced risk of antimicrobial resistance and drug residues
Limited mutilations	- Naturalness of system - Increased focus on disease avoidance - Potential risk for suffering in unsuitable production system (e.g. hens in free range system without good quality runs leading to feather pecking damage unless birds beak trimmed)	- Altered sensory quality of product as a result of trauma of or stress

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It has been reported that organic foods are no more nutritious than conventional foods. However, there is limited scientific support to suggest that organic foods contain more nutrients than conventionally produced products and further research is required to confirm this. Studies that have been conducted do suggest that higher meat quality is linked to grass-fed production systems used in organic systems, and this increased meat quality is mainly linked to fatty acid content in meat. The same could be suggested for organic fruits and vegetables which undergo all natural cycles during production, as opposed to production times being shortened through technology, careful environmental manipulations and use of GM seeds in conventionally grown fruits and vegetables.

2. How is Food Safety Regulated?

In addition to the food safety policy (discussed in section 1.), organic farmers and food producers have further restrictions resulting from the Organic Regulations, which are subject to a very strict control and enforcement regime to guarantee compliance with these regulations. Control authorities are appointed by member states and all organic farmers and food producers must be registered with their local organic control body before being able to legally market their products as organic.

2.1. Certification

Organic farmers and food producers must be registered with an EU approved Organic Authority and are subject to regular inspections to ensure they comply with a set of minimum certification standards, to produce, prepare, store or import organic products.

In the EU and elsewhere, all stages of the organic supply chain must be organically certified. Only after rigorous inspections by their registered organic control body, can full organic certification be awarded.

The initial certification acts as a contract between the accredited authority and the farmer or food producer. Certificates are issued documenting an annual licence (containing valid from/to dates, names, addresses and licence number/unique code) and a trading schedule (listing the activities and products covered under the organic license). Producers have an information schedule listing the enterprises, holdings and fields that are included under the organic certification.

2.2. Commitments for Certification (and Renewal)

When farmers and food producers begin their organic journey, they first decide what they will be producing and how they will achieve the organic standards. If changes are made during or after certification, their relevant certification authority must be informed.

The organic certification plan must contain a full description of all the farm buildings, fields and other units as well as a full list of activities being conducted. This includes the status of the fields (e.g., organic, in conversion to organic), the date of which any prohibited substances (such as chemicals, fertilisers) were applied to these fields and any facilities where goods will be received or stored. Where applicable, the plan must also contain information on the facilities for processing, packaging and labelling as well as any procedures used for transporting yields. Where livestock production occurs, details of any buildings, facilities for manure storage, grazing areas and open-air spaces, a detailed plan of how livestock will be managed, a detailed plan for spreading manure (previously agreed with the control body) and finally details of any premises used for storage, packaging and processing of livestock, livestock products and raw materials must be documented. This also applies to slaughterhouses/abattoirs (see section 4.2. Slaughter).

Where contractors are used, the plan must contain details of who they are, their activities and how they abide with the organic standards and criteria. A written agreement must be obtained with the contractors confirming they will meet any organic regulations, including details of the precautions taken to ensure full product traceability.

2.3. Inspections

Regular checks and further inspections ensure a greater control system within the entire supply chain aiming to tighten precautionary measures, increase robustness and ensure production standards are met. This is a physical inspection by an accredited organic authority of the farm's activities and occurs annually. Inspections can be pre-planned or unannounced.

Additional inspections may occur where non-compliance occurred previously, when new enterprises are added, seasonally activities occur, new premises are sought or complaints are received. A minimum of 10% of the certification body inspections are unannounced and a further 10% of the inspections are risk-based.

During the inspections the certification body verifies that activities in the original contract match that occurring on farm. They also verify if the activities occurring comply with the organic standards. Access to all areas within the farm business, including any non-organic areas, access to farm business accounts and any other relevant documentation regarding compliance must be given.

Physical samples may be collected (such as soil samples to ensure prohibited substances haven't been used). The certification authority must take samples from a minimum of 5% of their certified organic farmers and food producers' fields.

At the end of the inspection, the certification body will produce an inspection report highlighting any non-compliance or areas for improvement.

A declaration is signed by the farmer and food producer after every inspection, demonstrating they agree with the report and to ensure continued compliance with the organic standards.

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2.4. Non-Compliance

Non-compliance is simply when the activity conducted does not achieve the criteria set in the organic standards. These are highlighted during a physical inspection by the accredited authority. The level of the sanction will be proportionate to the extent and severity of the non-compliance as well as the level of risk it presents to the integrity of the organic product. Where a grey area occurs, the accredited authority will always err on the side of caution when it comes to organic products.

Under the EU Regulations/OF&G standards, there are different grades of sanction, which are:

- ✓ minor non-compliance: Failure to fit a specific standard such as poor record keeping or failure to fit farm assurance standard.
- ✓ major non-compliance: More serious breach of standards or failure to correct a previous non-compliance such as lack of animal health plan, accidental use of prohibited substance or failure to obtain a derogation.
- ✓ critical non-compliance or manifest infringement: Repeat failure to correct a previous non-compliance, or breach of standards considered to affect the integrity of the product/enterprise. This usually results in a loss of organic status.

In some cases, the non-compliance may lead to an instant suspension or even a withdrawal of the current organic license. Suspension, penalties and/or withdrawal occurs of organic status occurs when:

- ✓ Fees are not paid by the required time.
- ✓ A breach of the organic certification contract occurs.
- ✓ The accredited body was unable to arrange an inspection.
- ✓ An inspector is rejected access to the premises.
- ✓ An inspector is rejected permission to take a sample.
- ✓ Failure of the licensee to return certified sales declaration (CSD).
- ✓ Failure to return an action summary form by the required deadline.
- ✓ Severe or repeat occurrence of non-compliance.
- ✓ Fraudulent activity is observed.

After the inspection, the accredited authority will produce an Action Summary Form. It states any areas of non-compliance and requests information on how they will be resolved. Once a completed action summary form is returned to the accredited body and they approve the methods to correct the non-compliance, business can continue as normal. If a license was suspended or withdrawn, these are renewed.

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3. Food Safety: Up to the Farm Gate

3.1. Record Keeping

Record keeping is one of the most important methods for monitoring general farm activities as well as organic compliance. It also a legal requirement for many forms of farming and food producing across the globe. For organic farmers and food producers/processors, it is critical to prove organic status of a farm business. Without record keeping, there is no way to prove compliance has been achieved throughout production of organic products and no evidence to maintain organic integrity of the products. These records must contain information on all production activities, as well as all products bought in and all products sold or dispatched. This also acts as a record of traceability, providing further evidence of organic status. This is also a method of monitoring outputs and inputs on farm. These records can also be used to monitor procedures and animal health related activities, again to ensure they comply with the organic standards in place. These records must be kept for a minimum of 3 years for organic integrity purposes, but may need to be kept longer to comply with other EU legislation.

3.1.1. Record Keeping – General

In accordance with EU Regulations/OF&G standards, all records should include a minimum of the following:

- ✓ Proof of organic status of any products bought in (such as feed, livestock, seed) as described in Chapter Farm Management, sections 1. and 2. This may also include the composition of any bought-in feed to verify organic status.
- ✓ For any received goods: quantities, batches, invoices, delivery notes – again to ensure compliance.
- ✓ Evidence that organic and non-organic products were kept separately. For example, during storage, production and handling.
- ✓ A paperwork trail demonstrating hygiene standards were achieved before and during production (also known as cleaning and maintenance records).
- ✓ Further paperwork to identify any products sold, quantities and where they were sold to.
- ✓ Relevant paperwork for any pest control and fertiliser use.
- ✓ Conversion plan/conversion records, which becomes a management plan.
- ✓ Farm Biodiversity and Conservation Plan (see Chapter Farm Management, section 4. Environmental Considerations for Organic Systems).
- ✓ Farm Waste Management Plan.
- ✓ Annual stocktakes (if appropriate).

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In addition, as part of the organic standards, a complaints register must be kept documenting any complaints received, any made by the business, any response to complaints and any action taken as a result. This encourages transparency within the business and further verifies organic status of the business.

There are some specific records which must be kept for organic farming and food production in terms of plant production, livestock production, feed records and veterinary records, which are discussed in more detail below.

3.1.2. Record Keeping – Plant Production

For any organic plant/crop production, a minimum of the following records must be kept.

- ✓ Information on the use of fertiliser and soil conditioners including the date of usage, type and quantity applied and which fields they were applied to.
- ✓ Any use of pesticides of plant protection products, again including the types and quantity applied and which fields they were applied to. The method of application must also be recorded, as well as justification for their use.
- ✓ If any farm inputs are purchased, these must be documented as discussed in Chapter Farm Management, section 1.
- ✓ Finally, records of any harvesting of these products, the date, type and amount of organic crop produced must be recorded. Any 'in conversion' crops must also be recorded as described for organic crops.

On an annual basis, the accredited organic authority will request a cropping plan, whereby the farmer or food producer must state which fields will be used for which crop.

3.1.3. Record Keeping – Livestock Production

Livestock record keeping is essential regardless of organic status. It is a legal requirement for all farm businesses to keep accurate records of animal numbers, deaths, births, medicine usage and livestock movements regardless of organic status. When farming organically, these records will be more detailed in comparison to conventional farming records. According to the EU Regulations/OF&G standards, section 6 and section 8, for organic livestock production farmers must keep a record of the following:

- ✓ A register which lists all animals on the holding, which must be available at all times. It must provide a full record of the animals present, including livestock movements and livestock deaths.
- ✓ Each animal on the holding must have either an individual identification mark for large mammals or batch identification marks for smaller mammals (and poultry). They must be identifiable at all stages of their production including preparation, transportation and marketing (see section 4.2. Slaughter). Identification marks must be adapted to individual species.

- ✓ Livestock movements records for any animals which arrive or leave the farm business. When animals are brought in the farmer must record the:
- ✓ Species, source and quantity.
- ✓ Organic status of the livestock.
- ✓ Individual identification mark.
- ✓ List any quarantine measures which will be taken.
- ✓ Age of the animal/s.
- ✓ Date of arrival on farm.
- ✓ Veterinary history of the animal/s.

When animals are sold, the farmer must record the following:

- ✓ Species.
- ✓ Destination.
- ✓ Number sold.
- ✓ Individual identification mark of the animal/s.
- ✓ Age of the animal/s.
- ✓ Slaughter weight (where animal/s are going straight to slaughter rather than fattening).

Livestock deaths must also be recorded. This includes the species and number of animals lost as well as the reasons for mortality. Specific recording categories are required dependant on livestock species and are dependent on the animals' ages. See Table 2 for specific requirements.

Table 2. Livestock mortality records according to species and age of the animal

Specaes	Categories for recording mortality
Dairy	Number of losses per 100 cows calved for the categories below ✓ 0-24h (all calves including stillborn) ✓ 24h – 42 days (all calves) ✓ 42 days – 1st calving (dairy heifers only) ✓ 1st – 2nd calving (dairy heifers only)
	Number of planned culls
	Number of unplanned culls or casualty cows (died-killed on farm) in the last 12 months. A reason must be recorded.
	Number of enforced culls (e.g., TB)
	Number of cases of mastitis per 100 cows must also be recorded.
Beef	Number of losses by ✓ Stillborn-24h ✓ 24h – 10 days ✓ 10 days – weaning ✓ Weaning – 1st calving/point of sale ✓ Less than 30 months ✓ 30 months +

Sheep	Number of planned culls. A reason must also be recorded
	Number of unplanned culls or casualties (died-killed on farm) in the last 12 months. A reason must also be recorded
	Where possible, you must record the main reason for lambing losses
Pigs: Dry sows	Percentage of mortality (died but not actively culled) on farm in the last 12 months
	Percentage culls in the last 12 months
	Predominant cause of mortality must be recorded
Pigs: Finishers	Percentage mortality (died but not actively culled) on farm in the last 12 months or from last batch
	Predominant cause of mortality must be recorded

3.1.4. Record Keeping – Feed Records

Specific feed records allow verification that all animals on the holding are fed according to the organic standards. It acts as proof that any purchased feed and home-grown feed is produced organically, allowing the organic status of the farm to be maintained. Feed records must be in place to cover each animal group on the holding, allowing inspectors to easily understand which animal groups have been fed with what, as well as demonstrating all feed complies with the organic standards. As a result, the feed records must include:

- ✓ The type of feed (for example supplements, forage, straights or compound).
- ✓ The source of the feed.
- ✓ Percentage of each ingredient in animal ration.
- ✓ Amount of feed fed to each animal or animal group, including any non-organic feed.
- ✓ Organic status of the feed (e.g., organic, in conversion, or non-organic).

The farmer have to record when animals have access to any pasture, grazing or outside space/exercise areas, which includes any periods of transhumance.

3.1.5. Record Keeping – Veterinary Records

Veterinary records are essential for both organic and non-organic farming, but they act as verification that in organic systems, organic standards are maintained. Veterinary medicine can be described as products used to prevent or treat disease. Examples include antibiotics, parasite treatments, vaccinations, vitamins/minerals and herbal or homeopathic products. In organic farming, stress and disease is actively reduced by management practices such as access to pasture, air and increased space. This allows animals to express natural behaviours in their natural environment, removing the need for preventative treatment with veterinary products. It also prevents the need for prophylactic use of antibiotics, which is banned in organic farming. In addition to banning the routine use of antibiotics, organic standards also ban the routine use of anthelmintics and anti-parasitic drugs, which help to minimise antimicrobial resistance, protecting in increasing the effectiveness of these treatments on farm and globally. Animals are only treated when they are displaying symptoms of illness or disease. As a result, within organic systems, EU Regulations/OF&G standards state that you must record the following veterinary information:

- ✓ Date treatment commenced and finished.
- ✓ Reason for treatment.
- ✓ Name of the product, type, batch number and the active substance.
- ✓ Route of administration (e.g. oral, subcutaneous, intra-muscular, topical etc.).
- ✓ Number and identity of those treated (by individual animal or batch depending on how the animals are legally identified) and amount used.
- ✓ Legal length of the withdrawal period for this product according to the product specification (NOTE: this will be longer in organic systems than stated on the veterinary product, see section 3.2. Medicine Residues with Organic Derogations). Farmers must record the legal withdrawal period and the organic withdrawal period in their records.
- ✓ The earliest date the farmer can sell the animals or its produce to comply with organic standards.
- ✓ A record of which staff member administered the treatment/s.

In addition to the record keeping above, when any veterinary products are used, it must be reported directly to the accredited organic authority or certification body who will confirm if the animal or its products can still be marketed as organic.

Any stored veterinary products on the holding must be recorded in a veterinary medicine record and must have been prescribed for treatment on the holding. These products cannot be prescribed for prophylactic treatments in organic systems, therefore records of courses of treatments (as described above) must be maintained to demonstrate compliance during an inspection.

3.1.6. Record Keeping – Other Records

Staff training is one method of ensuring organic compliance in areas such as reducing risk of contamination, high animal health and welfare standards, cleaning etc. Staff competency must be monitored and documented, as well as adequate training provided to ensure organic compliance is achieved within all activities. This is true throughout the whole supply chain and not just at the farmer and food processor level.

Other records must be kept for organic compliance such as cleaning and pest control. Details of cleaning control records can be found in section 3.4. Cleaning. Acceptable chemicals and the processes associated with their use in organic systems can be found in this section too.

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Details of pest control records can be found in section 3.4.2. Cleaning – Pest Control. When products move off farm, further records must be kept. Details of transport records can be found in section 4.1. Transport. Finally, specific records for processing must also be kept in order to prove organic integrity was maintained throughout the whole supply chain. Details of slaughter record requirements can be found in section 4.2. Slaughter.

3.2. Medicine Residues within Organic Derogations

In organic farming, husbandry practices which strengthen the animals' natural defence against diseases and work to enhance the immune system are used to avoid the need for routine medicine usage. Exposure to unnecessary stress and/or diseases are reduced by such techniques (for example access to pasture, air and space). This allows the animals to express natural behaviours in their natural environment, removing the need for preventative treatment with veterinary products (such as the prophylactic use of antibiotics or routine anthelmintic use).

Organic standards ban the routine use of antibiotics and wormers, which also helps to minimise antimicrobial resistance, protecting the effectiveness of these treatments. Animals are only treated when they are displaying symptoms of illness, disease or injury. For information on what medical treatments are permitted in organic systems and those that are prohibited, see Chapter Farm Management, section 1.2. Organic Production Systems.

When animals are treated, appropriate records must be kept and animals clearly identifiable. See section 3.1.5. Record Keeping – Veterinary Records for specific information on what records must be kept when administering treatment to animals.

What classifies as treatment?

Organic standards define it as: "A course of treatment is all the measures you must take to restore your animal's health after a particular disease has occurred." When any treatment is administered, there are limitations on when you can sell those animals that have undergone treatment as well as limitations on when you can sell their products.

In organic systems, you must double the legal withdrawal period stated on any chemically synthesised allopathic treatments used before the animal/s and their produce can be sold. This cannot be shorter than 48 hours. Vaccines are exempt from this doubling period. For vaccines, the legal withdrawal period stated on the product is used in organic systems. The holding must have an appropriate method for ensuring that withdrawal periods are recorded, maintained and monitored. Withdrawal periods can usually be found on the bottle or box of the treatment or may be listed on the safety data sheet.

There are also limitations on the number of permitted treatments in organic systems. Except for vaccines, treatments and mandatory eradication plans for parasites in which an animal or group of animals has received more than 3 courses of treatment with chemically synthesized allopathic veterinary medicinal products or antibiotics within 12 months, or more than 1 course of treatment if their productive life cycle is less than 1 year, related live animals or products derived from them cannot be sold as organic products and live animals are subject to the conversion periods required by the legislation. See Chapter Farm Management, section 1.1. Converting Livestock to Organic from Non-Organic Systems for conversion periods. Any compulsory treatments that are required by law are permitted in organic systems.

3.3. Pesticide, Herbicide and Fertiliser Residues within Organic Derogations

Pesticides can be described as a substance or mixture of substances used to deter, repel, kill or prevent insects or organisms harmful to cultivated plants or animals.

It is said that around 400 pesticides are used across UK farming. They are often found in non-organic food, which is why some consumers prefer to opt for organic products as they limit exposure to pesticides.

The use of pesticides should be avoided in organic farming and is only allowed in specific circumstances and on very rare occasions. Organic farming relies on the natural balance between plants and animals to prevent pests. For example, wildlife such as birds, beetles, specific insects (ladybirds) are encouraged, as they eat common pests such as slugs, aphids, caterpillars. This way organic farmers don't need to use pesticides as they are using natural enemies of pests. Weeds are controlled by specific management practices, like the control for reducing pests and disease described below.

Organic farmers aim to reduce the need for application of pesticides, herbicides and fertilisers through practical management. Methods include crop rotation, crop selection, careful planning of planting dates, pre-emergence/post-emergence mechanical weeding and careful selection of crop varieties which are more resistant to disease. These management methods work naturally to control pests without the use of chemicals and thereby avoiding wider environmental damage. Most chemical herbicides are banned in organic farming. When there is a potential threat to any crops being grown in organic systems, there are a limited number of permitted products that can be used, but only when it can be demonstrated that the normal organic management methods have not been successful. These permitted pesticides can be found in table 3.

Table 3. Permitted pesticide used for plant protection in organic systems

Name of Product	Description, compositional requirements, conditions for use
Substance of plant and animal origin	
Allium sativum (Garlic extract)	
Azadirachtin extracted from Azadirachta indica (Neem tree)	

Beeswax	Only as pruning agent / wound protectant
COS-OGA	
Hydrolysed proteins excluding gelatine	
Laminarin	Kelp must either be grown organically in accordance with standard 15.7.4 (Art. 6d) or harvested in a sunstainble way in accordance with standard 15.7.3. (Art. 6c) of the Soil Association seaweed standards
Maltodextrin	
Pheromones	Only in traps and dispensers
Plant oils	All uses authorised except herbicides
Pyrethrins	Only from plant origin
Quassia extracted from Quassia amara	Only as insecticide, repellent
Repellents by smell of animal or plant origin / sheep fat	Only on non-edible part of the crop and where crop material is not ingested by sheep or goats
Salix spp. Cortex (aka willow bark extract)	
Terpenes (eugenol, geraniol and thymol)	
Basic Substances	
Basic substances based on food	Only those basic substances within the meaning of Article 23(1) of the Regulation (EC) No 1107/2009 that are covered by the definition of "foodstuff" in Article 2 of Regulation (EC) No 178/2002 and have plant or animal origin
	Substances to be used only for the control of pests and diseases - not as herbicides. Essential substances are substances that are useful in plant protection but are not predominantly used for this purpose. Many have traditionally been used in organic farming, and many are of food or plant or animal origin. Items that fall into this category are: - Lecithins, Sucrose, Fructose, Vinegar, Whey, Equisetum arvense L., Chitosan hydrochloride (obtained from sustainable fishing or organic aquaculture) Contact your certificate server for more info
Micro-organisms or substances produced by or derived from micro-organisms	
Micro-organisms	Not from GMO origin
Spinosad	
Cerevisane	
Other Substances	
Aluminium silicate (Kaolin)	
Calcium Hydroxide	Fungicide, only in fruit trees, including nurseries, to control Nectria galligena

Copper compounds in the form of: • Copper hydroxide • Copper oxychloride • Copper oxide • Bordeaun mixture • Tribasic copper sulphate	**Guidance:** In compliance with PPP legislation, you may use 4kg/ha max in any one year over provided that over 7 years you do not exceed 28kg/ha
Diammonium phosphate	Only as attractant in traps
Ethylene	
Fatty acids	All uses authorised, except herbicide
Ferric phosphate (iron (III) orthophosphate)	Preparations to be surface-spread between cultivated plants
Hydrogen peroxide	For seed treatment of lettuce and ornamentals and for disinfection of agricultural cutting tools used in Solanaceae
Kieselgur (diatomaceous earth)	
Lime sulphur (calcium polysulphide)	
Paraffin oil	
Potassium and sodium hydrogen carbonate (aka potassium/sodium bicarbonate)	
Pyrethroids (only deltamethrin or lambdacyhalothrin)	Only in traps with specific attractants; only against Bactrocera oleae and Ceratitis capitat Wied
Quarts sans	
Sodium chloride	All uses authorised, except herbicide
Sulphur	
Stone meal and clays	For example, ground basalt, bentonite, perlite and vermiculite
Humic and fulvic acids	Only is obtained by inorganic salts/solutions excluding ammonium salts; or got from drinking water purification
Xylite	Only if got as a by-product of mining activities (e.g. by-products of brown coaling)
Biochar	A pyrolysis product made of a wide variety of organic materials of plant origin and applied as a soil conditioner. Only from plant materials, untreated or treated with products listed in standards 2.6.2 Maximum value of 4 mg polycyclic aromatic hydro-carbons (PAHs) per dry matter (DM)

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Some fertilisers and soil conditioners are permitted (see table 4), but mineral nitrogen fertilisers are banned. In organic farming, records of any fertilisers or soil conditioners used must be kept, and these records need to demonstrate reasoning behind using those products. Soil micro-organisms, compost activators (made of microbial or plant extracts) and biodynamic preparations can be used providing they are authorised by local organic certifiers for use in organic systems and are not GMO or GMO derived.

Table 4. Allowed fertilisers and soil conditioners in organic systems

Name of product	Description, compositional requirements and conditions to use
Farmyard Manure (FYM)	Non-organic manure can not be from factory farming origins (defined below) or contain GM ingredients. Liquid animal manure has to undergo controlled fermentation and/or appropriate dilution before use.
Composted or fermented mixture of household waste	Product obtained from source separated household waste, submitted to composting or to anaerobic fermentation for biogas production. Just vegetable and animal household waste Just if produced in a closed and monitored collection systems, accepted by the Member State. Heavy metals concentration in mg/kg of dry mater can not exceed; cadmium: 0.7; copper: 70; nickel: 25; Lead: 45; zinc: 200; mercury: 0.4; chromium (total): 70; chromium (VI): not detectable
Peat	Use limited to horticulture (market gardening, floriculture, arboriculture, nursery stock)
Mushroom compost	This must be initially made from products permitted in this table
Dejecta of worms (vermicompst) and insects	
Guano	
Name of Product	**Description, compositional requirements and conditions for use**
Composted or fermented mixture of vegetable matter	Composts obtained from vegetable matter mixtures submitted to composting or to anaerobic fermentation for biogas production
Biogas digestate containing animal by-products co-digested wit material of plant or animal origin as listed in this table	By-products of animal origin (including by-products from wild animals) of category 3 and digestive tract content of category 2 (categories 2 and 3 as defined in Regulation (EC) No 1069/2009 of the European Parliament and the Council). Animal by-products can not be from factory farming origin. The processing must have been done in accordance with Commission.

Products or by-products of animal origin as below: Blood meal, Hoof meal, Horn meal, Feather meal, Bone meal or degelatinised bone meal, Fish meal, Meat meal, Hair and "chiquette" meal, Wool, Fur, Hair, Dairy products, Hydrolysed proteins	Hydrolysed proteins can not be applied to edible part of the crop. For furs the max level of chromium (VI) can not be greater than: not detectable **Advisement:** If possible, you should use organic products. Or it is more preferable to use products from extensive farming systems. Soil Association will continue its studies and studies on animal products obtained from organic or comprehensive systems in the future. If you are aware of any research or development in this area, please contact a member of the Standards Team: consultation@soilassociation.org If these inputs are considered, such as composts, farm manure or soft ground rock phosphate, non-animal alternatives to these inputs may be appropriate to treat nutrient deficiency. Animal products typically have readily available nitrogen and are only suitable where nitrogen loss is controlled.
Products/by-products of plant origin	Exp; oilseed cake meal, coca husks, malt culms
Hydrolysed proteins of plant origin	
Seaweed and seaweed products	For products which have been through the following processes: ✓ Physical processes involving dehydration, freezing and grinding ✓ Extraction with water or aqueous acid and/or alkaline solution or ✓ Fermentation
Sawdust and wood chips, composted bark and wood ash	The wood can not have been chemically treated after felling
Leonardite	Raw organic sediment rich in humic acid Just if it is obtained as a by-product of mining activities
Organic rich sediment from fresh water bodies formed under exclusion of oxygen (e.g. sapropel)	Just organic sediments which are by-products of freshwater body management or extracted from former freshwater areas Extraction methods should cause minimal impact on the aquatic system, if applicable, Just sediments derived from sources free from contaminations of pesticides, persistent organic pollutants and petrol-like substances Heavy metals concentrations in mg/kg of dry matter must not exceed cadmium: 0.7; copper: 70; nickel: 25; Lead: 45; zinc: 200; mercury: 0.4; chromium (total): 70; chromium (VI): not detectable
Chitin	The polysaccharide got from the shell of crustaceans Just is obtained from organic aquaculture or sustainable fisheries defined in Article 3e of Council Regulations (EC) No 2371/2002
Soft ground rock phosphate	Product as specified in point 7 of annex I A.2 of Regulation (EC) No 2003/2003 The cadmium content must be less than or equal to 90mg/kg P2O5

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Aluminium-calcium phosphate	Product as specified in point 6 of annex I A.2 of Regulation (EC) No 2003/2003 The cadmium content must be less than or equal to 90mg/kg P2O5 Use only allowed where the soil pH is greater than 7.5
Basic slag	Products as specified in point 1 of Annex I A.2 of Regulation (EC) No 2003/2003
Crude potassium salt or kainit	Products as specified in point 1 of Annex I A.3 of Regulation (EC) No 2003/2003
Potassium sulphate, possible containing magnesium salt	Products obtained from crude potassium salt by physical extraction process, possibly containing magnesium salts
Stillage and stillage extract	Ammonium stillage excluded
Calcium carbonate	Only of natural origin, for example chalk, marl, ground limestone, Breton ameliorant, phosphate chalk
Mollusc waste	Only from sustainable fisheries, as defined in Article 4 (1)(7) of Regulation (EC) No 1380/2013
	Guidance: You should also comply with Animal by-product regulations, for example in the UK
Egg shells	Must not be of factory farming operations
	Guidance: You could also comply with Animal by-product regulations, for example in the UK
Name of Product	**Description, compositional requirements and conditions for use**
Magnesium and calcium carbonate	Only of natural origins, for example magnesium chalk, ground magnesium, limestone
Magnesium Sulphate	Only of natural origin, for example kierserite
Calcium chloride solution	Foliar treatment of apple trees, after identification of calcium deficiency
Calcium sulphate (gypsum)	Just from natural origin Products as specified in point 1 of Annex I D of Regulation (EC) No 2003/2003
Industrial lime	Just as a by-product of sugar production from sugar beet or sugar cane or vacuum salt production of brine found in mountains
Elemental sulphur	Products as specific in Annex I D.3 of Regulation (EC) No 2003/2003
Trace elements	Just the inorganic micronutrient listed in Annex I, part E of Regulation (EC) No 2003/2003
Sodium Chloride	

As synthetic fertilisers are largely banned in organic farming, plant-based methods of crop nutrition are used. For example, using nitrogen fixing plants (clover, legumes) alongside green manures, animal manure and compost to enrich soils. Methods such as crop rotations are used to enhance the soil stability, soil structure, organic matter levels as well as using methods to prevent erosion, run-off and compaction.

3.3.1. Farmyard Manure

When it comes to using farmyard manure in organic systems, there are specific requirements in order to retain organic status. Ideally, any farmyard manure would be produced on site. However, when farmyard manure is brought in from outside the farm, it should be sourced from organically approved sources, and should preferably be composted. Records of the source, animal species and the husbandry system it comes from must be recorded and kept in the Farm Management Waste plan.

Where organically certified manure is not available there are criteria for non-organic manures which are permitted in organic systems. These are:

- ✓ Poultry manure and/or deep litter of free range egg production systems.
- ✓ Poultry manure and/or deep litter of systems where the maximum stocking density is 7 birds /m^2 .
- ✓ Poultry manure and/or deep litter from rearing systems where a max. stocking density of 20 kg/m^2 occurs.
- ✓ Poultry manure and/or deep litter of free range, traditional free-range systems and/or extensive indoor barn reared meat producing systems with a max. stocking density of 30 kg/m^2 .
- ✓ Cattle manure where cattle systems have access to pasture for at least part of the year.
- ✓ Pig manure from systems of straw-based production, where tethering sow breeding units do not occur.

Note: In all these systems animals have be able to freely rotate 360^0 for the majority, if not all their life cycle. Animals must not be permentanly kept in the dark in any of these systems.

When applying farmyard manure, further restrictions apply to ensure organic status is maintained. The maximum amount of organic nitrogen fertiliser that can be applied which must not exceed 170 kg of nitrogen per hectare per year (when averaged over the whole farmland area). Records of any such application must be kept. In nitrogen vulnerable zones (NVZs) the limit is set to 250 kg per hectare per year. Compost containing manures must be included in Nitrogen calculations, but green waste is not included. See table 5a-d for additional information regarding calculations.

Table 5a. Table for calculating the total nitrogen spread across organic farm systems

Solid Manure (per t or m^3)	N (kg)
Cattle farmyard manure (FYM)	6.0
Sheep FYM	7.0
Pig FYM	7.0

Table 5b. Table for calculating the total nitrogen spread across organic farm systems

Solid Manure (per t or m^3)	N (kg)
Poultry FYM	19.0
Broiler/Turkey FYM	30.0
Duck FYM	6.5
Horse FYM	7
Goat FYM	6

Table 5c. Table for calculating the total nitrogen spread across organic farm systems

Slurry liquid (per 1000l)	N (kg)
Cattle	2.6
Pigs	3.6

Table 5d. Table for calculating the total nitrogen spread across organic farm systems

Separated Manures (per 1000l)	N (kg)
Separated cattle slurry, liquid fraction, strainer box	1.5
Separated cattle slurry, liquid fraction, weeping wall	2
Separated cattle slurry, liquid fraction, mechanically separated	3
Separated cattle slurry, solid fraction	4
Separated pig slurry, liquid fraction	3.6
Separated pig slurry, solid fraction	5

Any surplus organic manure have be spread on other organic holdings where an agreement in writing is held for doing so. Where this occurs, the 170 kg of nitrogen per hectare per year must include this additional land in nitrogen calculations.

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3.4. Cleaning

Suitable cleaning measures must be in place to maintain integrity and prevent contamination of all agricultural products throughout all the production stages, and more so in organic systems than conventional ones. The EU Regulations/OF&G standards, section 11 state that "The cleanliness level must meet industry standards and prevent microbial, chemical or foreign body contamination of products. All product contact surfaces, including kitchen utensils, must be cleaned before organic production begins."

As a result, the cleaning regimes need to be clear and must detail:

- ✓ What will be cleaned.
- ✓ The method/s and/or equipment that will be used.
- ✓ which chemical/s will be used (they must be organically approved for the purpose – see section 3.4.1. Cleaning - Chemicals).
- ✓ Frequency required (daily, weekly, monthly etc.).
- ✓ Who is responsible for ensuring this cleaning process.

During organic inspections, cleaning and hygiene are observed and must be deemed appropriate and effective in order to pass the assessment.

Where organic and non-organic farming and food production occur in the same site, it is the farmer's responsibility to ensure that organic processing and/or storage only takes place once adequate cleaning of any processing locations, equipment and/or storage facilities has been carried out. Regular monitoring of cleaning routines must occur, and records must be kept demonstrating compliance. Examples of areas which must be cleaned include (but are not limited to) handling and harvesting equipment, containers for organic products, grain silos, animal housing and product packing areas. This is also true for abattoirs and slaughterhouses where organic and non-organic animals are processed. See section 4.2. Slaughter for more details.

3.4.1. Cleaning - Chemicals

There are various disinfectants, detergents, sterilants and sanitisers that are permitted in the food industry. However, where organic food may be in contact with such cleaned surfaces, farmers or food processors must ensure that all chemical residues have been removed to avoid contamination and maintain organic integrity of the products. A final rinse of all areas must be completed with potable water to ensure any traces or residues of chemicals have been removed. Some farmers and food processors choose to have dedicated equipment for organic processing to manage contamination risks.

With regards to livestock housing, only specific chemicals can be used in organic systems. They are as follows:

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- ✓ Water and steam.
- ✓ Milk and lime.
- ✓ Potassium and sodium soap.
- ✓ Quicklime.
- ✓ Lime.
- ✓ Sodium hypochlorite (e.g. bleach – liquid form).
- ✓ Caustic soda.
- ✓ Hydrogen peroxide.
- ✓ Caustic potash.
- ✓ Natural essence of plants.
- ✓ Formaldehyde.
- ✓ Citric, peracetic, formic, lactic, oxalic and acetic acid.
- ✓ Alcohol.
- ✓ Cleaning and disinfection products for teats and milking facilities.
- ✓ Sodium carbonate.

In dairy systems only phosphoric acid and nitric acid on the dairy equipment may be used.

It is essential that this list is checked against the specific national organic requirements.

3.4.2. Cleaning – Pest control

In all farming systems, pest control should aim to prevent any infestations, rather than treat the problem with chemicals. This is very similar to the use of veterinary treatments in organic systems. The preferred aim is to design the system to avoid the need for additives. Methods for pest control in organic systems include (but are not limited to):

- ✓ Appropriate crop rotations.
- ✓ Creating fertile soils with high biodiversity.
- ✓ Protecting and/or encouraging natural pest enemies, or introduce natural pests.
- ✓ Grafting on resistant rootstock.
- ✓ Choosing species and varieties that are resistant to disease and pests.
- ✓ Thermal processes.
- ✓ Carefully planning planting dates.
- ✓ Mechanical and physical methods.
- ✓ Pre-emergence and post-emergence mechanical weeding.
- ✓ Using good husbandry practices and high standards of hygiene to limit the spread of disease and pest infestations.
- ✓ Sterilising buildings and equipment using steam method.

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Examples of active pest control to reduce the risk of pest contamination include effective covers for all waste bins, sealing gaps and entry points, use of fly screens and pheromone traps. Specifically in livestock areas, urine, faeces and any uneaten food must be removed to reduce the risk of infestation by rodents and insects.

If an infestation occurs, records must be kept of:

- ✓ What pest have been found.
- ✓ Any chemicals used, the method for treatment and any equipment used.
- ✓ Person who treated the infested area.
- ✓ When treatment was used.
- ✓ Any precautions taken to prevent the risk of contamination to organic products.
- ✓ When used in livestock housing, precautions for contamination to livestock must be recorded.

This record keeping must also be done in any non-organic infested areas in premises where organic products are also produced. A risk assessment of contamination must be carried out and appropriate measures taken.

Other organic regulations on pest treatment include the requirements that rodenticides must only be positioned in places where there is no risk of contamination to products and must have been stored in tamper-proof bait stations.

Organically approved control measures for controlling an infestation on organic products include vacuum treatment, freezing and heating and carbon dioxide or nitrogen. When infestation occurs in organic areas but not on organic products directly, the use of tamper-proof bait stations, electric flying insect control units, desiccant dusts preferably from naturally occurring sources and humane electronic rodent repellents are all allowed. There are further organic regulations when treating infestations in livestock housing. Table 3 lists permitted substances for treating pest control in organic systems.

3.5. Staff Competency

Staff training is one method of ensuring the risk of non-compliance is minimised. Staff competency must be monitored and documented, as well as adequate training provided to ensure organic compliance is achieved on organic sites. The EU Regulations/OF&G standards, section 11 state that “All personnel (including goods receipt, processing, packaging and cleaning personnel) with a level of authority that can affect the integrity of organic products must fully understand the processes of organic procedures. And these personnel should be trained to follow these procedures. Records of this training should be kept.”

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4. Food Safety: Past the Farm Gate

4.1. Transport

To maintain product quality and reduce the risk of contamination, appropriate food handling and transport protocols must be used.

During the transporting of organic and non-organic products, measures must be in place to prevent any mixing, contamination or exchanges between products. Collection records need to include collection days, hours, route travelled, and time/date products were received. When transporting organic products to other companies, measures must be in place to ensure there is no risk of substitution. Products must also be labelled clearly (or with attached documentation) allowing the recipient to easily identify what the product is, its organic status as well as the name and address of where it has come from. The certification code, traceability code and organic % of product must also be stated (either on the label or in the attached document). See section 4.3. Processing, Labelling and Traceability, for more details on this.

When transporting organic animals, stress must be minimised during handling and transportation itself. EU Regulations/OF&G standards, section 12 state that “no person shall transport any animal in a way that causes, or is likely to cause, injury or unnecessary suffering to that animal.” This is true of conventional systems as well as organic systems. Animal transport needs to be appropriately planned and managed by both the livestock keeper and those receiving the animals to minimise unnecessary stress and discomfort. Handling and transport times should be kept to a minimum where possible, which helps to reduce any stress or discomfort. In line with the EU Regulations/OF&G standards, section 12, animals should have access to organic food, water and 24h rest before starting their journey. The use of electric goads is forbidden under organic regulations and cannot be used to encourage animals on and off trailers. Unnecessary long journey times are also prohibited in organic systems, and it is a requirement that very young and heavily pregnant animals are not transported, including:

- ✓ Cattle over 6 months in-calf (65% of their pregnancy).
- ✓ Ewes over 3 months in-lamb (65% of their pregnancy).
- ✓ Calves under 1 month old, or under 12 weeks old without dams.
- ✓ Lambs and kids under 45 days old without ewes or nannies.

An unnecessary long journey time is defined as anything over 8 hours from the time the first animal is loaded, to the time the last animal is unloaded. However, there may be country-specific regulations which shorten this period further. For example, in Germany, transport should not last longer than 4 hours. Any journey that is perceived as “excessive” will be prohibited or will need prior approval through justification process with local organic authorities.

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4.2. Slaughter

Like organic farmers and food producers, abattoirs must undergo an annual certification and inspection process in order to legally process organic stock. During inspections, abattoirs will need to demonstrate that activities undertaken comply with organic regulations, and a report detailing compliance or any areas of non-compliance found will be produced by the organic inspector. As explained above in section 2.3. Inspections, the inspectors must have access to all areas of the premises and samples will be taken to assist in assessing compliance.

One of the main organic standards is that animals will be treated ethically, meeting their species-specific behavioural and physiological needs. This includes transport to an abattoir, unloading at the abattoir, as well as their experience within the abattoir itself. Upon arrival, the abattoir staff must check organic certification documents of the supplier, ensuring the name and address on the organic certification match that of the name and address of the supplier. The certification must also be checked to ensure it covers the organic products being received and that the certification is valid at the time of slaughter. A record of these checks must be made. Movement records must also be completed as described in section 3.1.3. Livestock Production.

All abattoir records must be kept for a minimum of 12 months to allow traceability of the products to ensure the integrity of organic products and their organic status. Records may need to be kept longer to comply with other laws. For organic integrity the following records must be kept:

- ✓ Livestock seller information and evidence that abattoir staff have checked the organic status of the animals.
- ✓ Quantities, batch codes, invoices and delivery notices of organic livestock received.
- ✓ Kill number, kill date, kill time, batch code/ear tag identification number and carcass weight.
- ✓ Quantities produced in each production run.
- ✓ Evidence that organic and non-organic animals were processed separately.
- ✓ Evidence that cleaning and hygiene standards were achieved and maintained.
- ✓ Training of staff competencies for organic procedures used in house.
- ✓ Records of any pest control used.

Section 3.4. Cleaning also applies to abattoirs when maintaining organic integrity.

Animal housing in the abattoir (lairage), between transport and slaughter, must also meet organic standards in terms of animal health and welfare. Organic maximum stocking densities must not be exceeded, and animals should be able to express natural behaviours. Housing should also allow species-specific physical and developmental needs to be achieved. Stock persons in charge of these animals must be trained accordingly and be proficient in ensuring high standards of animal health and welfare are maintained. Suffering must be kept to

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a minimum during the animals' life including at the time of slaughter. Organic and non-organic animals must be kept separate from each other. Pens must be labelled to ensure all staff are aware which pens contain organic livestock. Animals should have "sufficient space to stand up, lie down and turn around without difficulty when penned." All animals must arrive identified in compliance with the legal requirements of the country. As with rearing organic animals, isolation and tethering is prohibited unless under veterinary advice, for staff safety or animal welfare reasons. EU Regulations/OF&G standards, section 12 state that "The optimum practice should be: Animals should be transported from the dumping area to the catchment area. If possible, it should be transported directly to the stunning/cutting area. There should be as few turns and corners as possible in the passage route of the animals. In addition, the path followed by the animals should be such as to facilitate forward movement." Where animals are likely to be held longer than 12 hours in the lairage, animals must be fed with organic feed.

Evidence in the form of invoices, intake forms, contracts with producers must be kept demonstrating that organic integrity was maintained. Water must always be available during lairage regardless of organic status. Any animals being kept longer than 12 hours in the lairage must also be provided with appropriate bedding material unless the lairage has a slatted or mesh floor. Floors should be non-slip in all areas. Any natural bedding must be compliant with organic standards to be used with organic animals.

CCTV must be installed in these premises where more than 1,000 livestock units are slaughtered or 150,000 birds per annum. Where national law is not in place, CCTV with good visibility must be in place during the following activities:

- ✓ Unloading from vehicle into lairage.
- ✓ During lairage up to and including the movement towards the point of electrical stun.
- ✓ At stunning and including the movement up to this point.
- ✓ During any shackling of animals.
- ✓ During any sticking of animals.
- ✓ When entering a controlled atmosphere system (CAS).

Footage must be kept for a minimum of 3 months and be available on inspection for organic authorities to view on request. CCTV footage must be used by animal welfare staff and abattoir staff to monitor, observe and improve (where possible) high animal welfare standards on a regular basis.

During the slaughter process, all organic animals must be stunned beforehand. There are no exceptions for religious slaughter in European abattoirs. Permissible stunning methods and special requirements for their proper activation are set out in Annex I to EC Regulation 1099/2009. To ensure that animals are effectively stunned, Annex I of Regulation 1099/2009 must be observed. As a result, "OF&G requires that animals are pre-stunned to render them insensible before being killed. So these requirements does not endorse those religious methods of slaughter where the animal is fully sensible when being killed." Stunning is essential to ensure animal welfare is maintained, even at the point of slaughter.

For slaughter specifics see EU Regulation/OF&G section 12. Other than those detailed above and in section 12 of the regulation, the slaughter process itself is not detailed in the organic standards as these processes are governed by other legislation irrelevant of organic status of the livestock.

If animals need to be slaughtered in third countries. During this cutting process, the requirements of Council Directive Regulation (EC) No 1099/2009 must be complied with. This ensures protection of animals at the time of killing or equivalent.

4.3. Processing, Labelling and Traceability

Any processing of organic products requires organic certification for the premises being used. Operations such as storage, warehousing or distribution of organic products are also classified as organic and will require certification.

Processing of meat includes the following procedures: cutting, chilling and dressing of carcasses into primals or cuts, storing, importing, packing or repacking, labelling or the wholesaling/retailing of organic products.

Processing of products is one of the high-risk points within the supply chain at which contamination can occur. It can also compromise the integrity of the organic status, if not processed correctly. It has also been shown to be one of the major risk points for introducing zoonotic agents. The link between frequency of carcass contamination with various bacterial agents and human illness has already been demonstrated. Therefore, adequate methods must be in place to prevent contamination of products during processing. Any processing techniques must be carried out in line with organic standards. Preferably this is through using biological, physical or mechanical methods without the need for additives or processing aids. Any additives or non-organic ingredients added during processing must only be used when necessary and comply with organic standards. Prohibited substances or processing methods which may mislead the consumer on the organic status of the product must not be used.

As mentioned above, labelling is key during processing to ensure organic products are kept in compliance with organic standards. Labelling refers to the method for identifying products and to show their organic status. Labelling standards apply to live animals, carcasses, primals, delivery notes or invoices when being transported in bulk and when advertising (such as website content). Labelling must not be misleading or inaccurate when describing the product.

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4.3.1. The Organic Logo

The organic logo was introduced by the Commission Regulation (EU) No 271/2010 on 24th March 2010. Any organic products sold in the EU and Northern Ireland which meet the strict organic criteria (described in Chapter Farm Management) can carry the organic logo, shown in figure 4.

Figure 4. The organic logo

This allows a visual identity and makes it easier for consumers to identify organic products within the market. Only farmers and food producers who are fully certified as organic can use this logo on their products, again ensuring specific standards are met for production, processing, transportation and storage.

According to EU Regulation/ OF&G standard, section 4, if this logo is displayed, consumers can be assured that 95% of the ingredients within the product are fully organic and the remaining 5% meet further strict conditions.

To add further confidence, alongside the organic logo will be a code number of the control body or certifier code and the location of where any raw materials within the product have been farmed (see figure 5). It is a legal requirement to display the certifier code.

Figure 5. The Organic logo and required text on all organic products

For products with less than 95% organic ingredients, the individual organic ingredients can be identified in the ingredients list.

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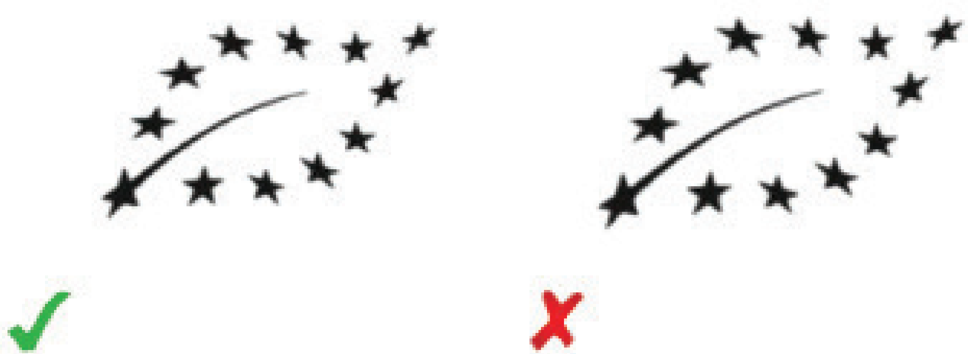
Table 6. Shows a summary of the main differences in labelling between those products with >95% organic ingredients and those with less than 95% organic ingredients

% organic agricultural ingredients	References to organic	EU Organic logo (optional unless in NI)	Certification code	Statement of agricultural origin
More than 95%	✓	✓	✓	✓
Less than 95%	Only in ingredient list	✗	✓	✗
In-conversion product	You may use the wording 'product under conversion to organic farming'	✗	✓	✗

There are also strict criteria on how the logo must be displayed. It must be a specific size (no smaller than 13.5mm by 9mm). Where this is not achievable due to packaging size, 9mm by 6mm is permitted. In all cases, the height to width ratio must be 1:1.5. The colour of the logo cannot be changed and must be displayed in the standard green and white colour scheme shown in figure 5.

The white EU logo with black stars is acceptable on a dark background only, or white stars on black background where colour is not available (see figure 6 for visual image). When this is used, it must appear in within a box (also shown in figure 6). Stylisation is not acceptable, such as 3D effects or transparent backgrounds.

Figure 6. The acceptable black and white version of the organic logo



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The logo cannot be used under the following circumstances:

- ✓ Products containing <95% organic ingredients.
- ✓ In large scale catering such as restaurants, hospitals etc.
- ✓ Products not in the ethos of organic rules (cosmetics, products from hunting).
- ✓ Products that are undergoing conversion (where organic methods are currently being introduced and there is a risk that non-organic products/substances may still be in the animal or soil).

4.3.2. Meat Stamps

EU Regulation/OF&G standard, section 12 state that "Carcasses and meats must be stamped with a stamp identifying the slaughterhouse where the animals were slaughtered. All carcasses and meats must be traceable throughout the consignment of the delivered animals. Therefore, the shipment process of the meat should be followed up to the producer. In additional, all organic carcases and cuts (other than poultry) should be stamped with an 'organic' stamp."

When an abattoir becomes licensed as organic, they are provided with a meat stamp to stamp carcasses, sides, quarters and primals. Specific staff are only able to stamp the meat (once they are competent at checking organic status of products). A meat stamp must be applied to the primals as soon as possible after slaughter.

There are also specific regions which the stamp must be place, depending on the species of meat being stamped. These locations are:

- ✓ Beef sides: each hind quarter and fore quarter.
- ✓ Sheep carcasses: on both hind legs.
- ✓ Pork carcasses: on both hind legs.
- ✓ Where part carcasses are supplied: each cut.
- ✓ Poultry are exempt from meat stamps, however information to provide traceability should be on the packaging or dispatch information.

Organic meat stamps can only use colours in accordance with article 2(8) of the directive 94/36/EC.

Meat stamps are vitally important to ensure organic products are traceability throughout processing and storage.

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4.4. Storage

As with other areas of the processing chain, separation of organic and non-organic products during storage is essential to maintain their integrity. Organic storage areas and containers must be managed to allow organic and non-organic products to be easily identified and also prevent them mixing. Storage facilities and methods must also prevent contamination from external sources which are prohibited in the organic standards. Examples of storage methods to meet organic standards include:

- ✓ Separate storage/hanging rails for organic and non-organic products. Organic products must not be in direct contact with non-organic products. Where separate rails are not available, plastic curtains could be used for separation.
- ✓ Carcasses are labelled as organic on luggage tags to allow clear identification of organic status.
- ✓ Hanging and labelling offal from organic carcasses immediately after removal to avoid mixing with non-organic offal.

If the same equipment is used for organic and non-organic products during storage, clear labelling and separation must be in place to avoid mixing or contamination. Areas and equipment must be cleaned between handling non-organic products and organic products to maintain organic integrity. Processing of batches of organic products should be undertaken before non-organic processing occurs. This will reduce the risk of contamination or mixing of products. Cleaning between batches is essential. Further details on cleaning under organic regulations can be found in section 3.4. Cleaning.

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