MEDITERRANEAN

Pollution Prevention in the **Meat Processing Industry** in the Mediterranean Region

CLEANER production

Regional Activity Centre for Cleaner Production (RAC/CP)
Mediterranean Action Plan

UNEP

MAP

Regional Activity Centre for Cleaner Production

Ministry of the Environment Spain

Generalitat de Catalunya
Government of Catalonia
Department of the Environment and Housing

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If you should consider that any point of this study could be improved or that there is any inaccuracy, we would be grateful if you could inform us of this.

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CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

EXECUTIVE SUMMARY

Background, aims and scope of the manual (Chapter 1)

This *Manual for Pollution Prevention in the Meat Industry in the Mediterranean Region* has been drawn up in the context of cleaner production with the aim of presenting, in an up-to-date manner, the opportunities for pollution prevention and reduction at source taking into account the characteristics and special features of this sector in the different countries of the Mediterranean Action Plan (MAP), which include the following: Albania, Algeria, Bosnia & Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Serbia & Montenegro, Slovenia, Spain, Syria, Tunisia and Turkey, and in the European Union as a whole.

The application of pollution prevention alternatives through the minimisation of emissions at source makes it possible to reduce the consumption of natural resources (water, energy and raw materials), reduce waste streams, and increase the effectiveness of production processes, resulting in increased industrial competitiveness.

Analysis of the situation of the meat sector in the MAP countries (Chapter 2)

Chapter 2 of the manual analyses the situation of the meat sector in the MAP countries. In this analysis the production, consumption and trade of each country are identified, revealing, in summary, that in the majority of countries meat production is lower than consumption, due to which they must resort to imports (only France, Spain, Tunisia and Slovenia have positive net trade balances), and that the principal producers are also the principal consumers.

It should also be pointed out that there are substantial differences in meat production among the MAP countries, with over 84 % of the total being produced between France, Spain, Italy, Egypt and Turkey - the principal meat production being pork, with 32.7 % of the total, followed by chicken with 27 % and beef with 22.5 %.

Description of the principal production processes in the meat industry (Chapter 3)

Chapter 3 is divided into five sections: 3.1.Slaughterhouses and cutting plants; 3.2. Manufacture of meat products; 3.3. Auxiliary processes; 3.4. Cleaning and disinfecting; and 3.5. Meat by-products and waste.

The principal production processes in the meat industry are described in Sections 3.1 and 3.2, in which three types of activity are distinguished:

- The slaughter of animals in slaughterhouses.
- The cutting and portioning of carcasses in cutting rooms.
- The production of meat products in production plants.

These sections study the structure and characteristics of the meat industry, taking into account the different countries that make up the Mediterranean region, with the aim of identifying the special characteristics that exist among the different countries, and their translation into the productive practices and techniques applied in the meat industries, such as the case of Muslim countries and Israel, where meat processing is determined by the Muslim rite (Halal slaughter) and the Jewish rite (Kasher slaughter), respectively.

In the description of the industrial processes of the sector these are structured as follows:

- Slaughterhouses and cutting rooms for livestock:
  - Cattle, sheep and goat
  - Pigs
  - Poultry
- Manufacture of meat products (cooked and cured) on the basis of:
  - Beef, sheep/goat meat
  - Pork
  - Poultry

The principal operational stages are described for each of the industrial processes. By way of example in the production process of slaughterhouses and cutting plants for cattle, sheep and goats, the following operations are described: reception and lairaging, stunning and hanging, bleeding, hoof and horn removal, flaying, removal of the head, evisceration, cutting of carcass/splitting, washing, chilling/refrigeration, cutting and refrigeration-freezing.

Section 3.3 describes the auxiliary processes in the meat industry: Generation of heat, generation of cold, water conditioning, waste treatment and maintenance of equipment, installations and services. Generally, these processes may have some type of impact on the medium through the environmental aspects that they generate.

Due to the high risk of microbiological contamination of meat products, industrial hygiene operations acquire special relevance; hence in Section 3.4 the operations, products employed, plans, equipment and cleaning and disinfection systems that are most habitually used are described.

Section 3.5 describes the internal management process of meat by-products and waste, ranging from the characterisation, classification and quantification of the by-product or waste, the pattern of generation, conditions of collection, storage and conditioning, to their being handed over to an authorised waste manager.

Environmental aspects of the meat industry (Chapter 4)

The principal environmental aspects and impacts generated in the meat sector are those related to: wastewater, waste, atmospheric emissions, noise, energy consumption and water consumption.

Chapter 4 describes the most significant aspects of the meat industry on the basis of the activities that are carried out and their interaction with the environment.

In the meat sector it should be pointed out that:

- Water is used in the majority of operations for cleaning and disinfecting equipment, installations and work utensils.
- The principal sources of energy consumption are the generation of heat energy for the production of steam and hot water, as well as the refrigeration installations.
- The most significant environmental parameters correlated with wastewater are suspended solids (SS), the organic load expressed as the chemical oxygen demand (COD) and the five-day biological oxygen demand (BOD_5), as well as oils and fats, nitrogen, phosphorus, salts, and detergents/disinfectants.
- The principal types of waste generated can be classified into: organic by-products, hazardous waste, high-risk material and waste similar to municipal solid waste.
- The main atmospheric emissions are generated in the production of hot water/steam, and during scalding and cooking, and are principally made up of the combustion gases CO_2, NO_X, SO_X and CO.

- Noise generation of is principally related to the reception, lairaging and slaughter of livestock, refrigeration equipment and automated transport systems.

Opportunities for pollution prevention and reduction at source in the meat industry (Chapter 5)

From the perspective of pollution prevention and reduction, Chapter 5 describes the principal opportunities for the sector, focusing on: reducing water consumption in production processes and in cleaning and disinfecting operations, reducing energy consumption, reducing the pollutant load of wastewaters, segregating the waste streams to facilitate subsequent recovery, optimising wastewater treatment processes, and the recovery of by-products and waste.

In addition to environmental criteria, to carry out the prevention activities, public health hygiene requirements, the quality of the product, productivity, technology available and economic viability have all been taken into consideration.

The pollution prevention opportunities are explained for the principal production process in a table describing the improvement action, the process referred to and the improvement obtained.

Pollution prevention opportunities (PPO) have been classified as follows:

- PPO Classification
- Process modification PM
- Incorporation of new technologies NT
- Raw materials substitution RMS
- Implementation of good environmental practices GEP
- Implementation of good hygiene practices GHP
- Recovery R
- Treatment T

Examples of case studies of opportunities for pollution prevention and reduction at source in the meat industry (Chapter 6)

Chapter 6 gives four real case studies of the application of pollution prevention alternatives in the meat industry, describing actions consisting of:

- Reduction of energy consumption through the use of meat product waste.
- Reduction of the organic load in wastewater by modifying blood collection operations.
- Reduction of the organic load in wastewater through the application of good environmental practices.

Conclusions and recommendations (Chapter 7)

This chapter deals with the recommendations and principal conclusions reached regarding the overall situation of the meat sector in the countries of the Mediterranean Action Plan (MAP) in the context of meat production, environmental aspects and problems and opportunities for pollution prevention and reduction at source.

1. BACKGROUND, AIMS AND SCOPE OF THE MANUAL

The Cleaner Production Regional Activity Centre (CP/RAC) is an organisation that operates within the framework of the United Nations Environmental Programme (UNEP). More specifically, since 1996 it has formed part of the Mediterranean Action Plan (MAP). One of the principal objectives of the CP/RAC is the promotion and dissemination of pollution prevention and reduction at source in the industrial sector, as well as providing technical support for businesses and institutional organisations through the promotion of more eco-efficient practices and techniques in these matters.

Within the framework of its activities, the CP/RAC produces various publications and technical documents aimed principally at small and medium-sized enterprises in relevant industrial sectors within the Mediterranean region.

In this sense, this has led to the preparation of the present manual, ***Pollution Prevention in the Meat Processing Industry in the Mediterranean Region.***

The principal aim of the *Pollution Prevention in the Meat Processing Industry in the Mediterranean Region* manual is to present the opportunities for preventing pollution in the meat processing sector in a clear, simple and up-to-date manner, taking into account its characteristics, and special features in the different countries of the Mediterranean region, such as the case of Muslim countries or Israel, where meat processing includes requirements defined by the Muslim rite (*halal* slaughter) and the Jewish rite (*kosher* slaughter), respectively.

The Mediterranean Action Plan (MAP) member countries that make up the territorial setting for the study, are as follows: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco[1], Morocco, Serbia and Montenegro[2], Slovenia, Spain, Syria, Tunisia and Turkey. Similarly, the European Union as a whole has been considered for the study.

It should be mentioned that as all data sources consulted on the production, consumption and trade of meat in the MAP countries are from 2004, all data on the meat sector in Serbia and Montenegro are presented jointly. On the other hand, no data relating to the meat sector in Monaco have been located on either global or individual levels

The working methodology used in the preparation of this manual is based on the eco-management manual *Pollution Prevention in the Meat Processing Industry* published by the Centre for the Enterprise and the Environment of the Catalan Department of the Environment and Housing, along with well known, wide-reaching work carried out by the United Nations in the field of cleaner production. This document has subsequently been expanded on and updated by taking into account, principally, the documentation produced by the EIPPC Bureau (BREF document on the European food sector), the Ministry of the Environment (Guide to Best Available Techniques in the Meat Processing Sector in Spain) and technical information available from a number of organisations in countries in the southern Mediterranean basin.

[1] See Chapter 2 page 53

[2] See Chapter 2 page 56

At the same time, we have studied the structure and characteristics of the meat industry in the different countries that make up the Mediterranean region, with the aim of identifying the special characteristics that exist between the different countries and their translation to the productive practices and techniques applied in the meat industries.

Similarly, other technical reference documents have been consulted and analysed during the production of this manual, among which the following are worthy of mention:

- EIPPCB: *Reference Document on Best Available Techniques in the Slaughterhouses and Animal By-products Industries*. European Integrated Pollution Prevention and Control Bureau, 2005.
- UNEP: *Cleaner Production Assessment in Meat Processing*. United Nations Environment Programme, 2000.
- MINISTERIO DE CIENCIA Y TECNOLOGÍA, AINIA and EOI: *Aplicaciones del manual media a sectores industriales: sector cárnico*. Fundación Escuela de Organización Industrial, Madrid, 2001.
- EIPPCB: *Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems*. European Integrated Pollution Prevention and Control Bureau, 2001.
- QUEENSLAND GOVERNMENT: *Eco-Efficiency Manual for Meat Processing*. Meat and Livestock Australia, 2002.

This manual is aimed principally at all those businesses in the meat sector that require guidance when making decisions of a technical and environmental nature concerning their facilities, and it will be of particular interest to those businesses that need to adapt to the requirements of integrated environmental permitting, as defined in Council Directive 96/61/EC of 24 September 1996.

The manual will also be a useful document for public administrations, and will be a reference tool for work carried out in consultancy and engineering firms and technological centres, as well as for students.

Furthermore, it should not be forgotten that it may be a useful tool for application in southern and eastern Mediterranean countries, given that this manual focuses primarily on pollution prevention opportunities that may be applied to the meat sector in general, taking as a priority the reduction of pollution at source and the exploitation of by-products, which in certain cases entails modifications to production processes and, consequently, changes with regard to the requirements of raw materials, new processing and monitoring technologies and good environmental management practices. These changes make businesses in the sector more respectful of the environment, guarantee the hygienic and commercial quality of the products, and facilitate their establishment in more demanding markets.

The manual includes the following sections and contents:

- Description of the meat sector in the Mediterranean region

  The situation of the sector in each of the countries of the Mediterranean Action Plan is described, presenting the sector, as a whole, in the region.

- Description of industrial processes

  Description of raw materials and resources used (main and auxiliary), the processes involved (main and auxiliary), and the finished products. This section includes specific sub-sections dealing with the cleaning, disinfection and management of meat by-products and waste.

- Description of the waste streams generated

  Description and quantification of the waste streams that are generated (wastewater discharge, hazardous organic and packaging waste, gas emissions, odours, noise emissions, etc.) and the main types of environmental impact.

- Description of opportunities for pollution prevention at source

A description is made of each of the selected prevention alternatives, including the following sections:

- Description of the prevention opportunity.
- Process to which it is applied.
- Classification of the alternative in some of the following categories: process modification of, incorporation of new technologies, raw materials substitution, introduction of good environmental practices, introduction of good hygiene practices, recovery and treatment.
- Improvements obtained.

- Case studies

A number of real case studies or examples of the application of pollution prevention alternatives are included.

- Conclusions

Written taking into account the objective of the document and its intended readership.

- Recommendations

A number of recommendations are included aimed at the CP/RAC and the MAP countries for implementing actions to promote the meat sector in the Mediterranean region.

2. SITUATION ANALYSIS OF THE MEAT SECTOR IN THE MAP COUNTRIES[3]

2.1. GLOBAL SITUATION OF THE MEAT SECTOR IN THE MEDITERRANEAN ARC COUNTRIES

2.1.1. Total production of meat in the MAP countries, and proportion in world production

In 2004 the countries in the Mediterranean Arc produced a total of 22,706,240 tonnes of meat. In recent years, this figure has increased progressively, as can be seen in Table 2.1, since the average for the period 1979 -1981 was 14,332,000 tonnes. Nevertheless, with respect to world production, the proportion of these countries has fallen, dropping from 10.53 % of world production for the period 1979-1981 to 8.9 % in 2003. This is due to an even greater increase in world meat production.

There are significant differences with regard to the quantity of meat produced between the MAP countries. The principal producers are France, which occupies first place with almost 29 % of the total production of these countries, followed by Spain, Italy, Egypt and Turkey. These five produce over 84 % of the total for the Mediterranean Arc countries. With regard to worldwide production, France accounts for 2.7 %, and the sum of the figures for the five principal producers of the Mediterranean Arc is 7.49 % of all meat produced worldwide.

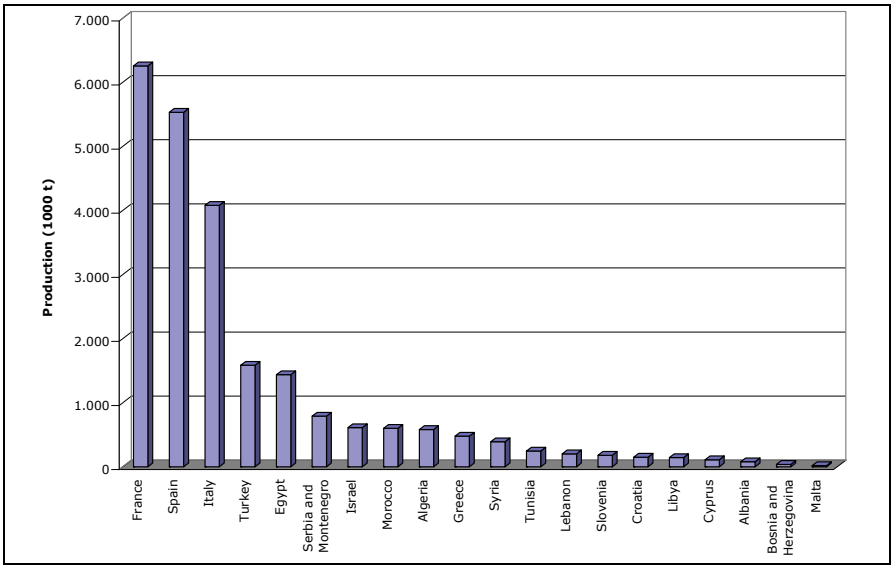


Figure 2.1: Meat production in the Mediterranean Arc countries (2004).
Source: Food and Agriculture Organization of the United Nations.

[3] Due to the fact that the sources are from 2004, in this chapter the data on Serbia and Montenegro are given together. The currency conversion from US dollars to euros was done at the rate valid on 24/12/04 of $1 = €0.73314.

Table 2.1: Total production of meat in the Mediterranean Arc countries, and proportion in world production

	PRODUCTION (1,000 t)						% WORLD PRODUCTION					
Country:	**1979-1981**	**1989-1991**	**1999-2001**	**2002**	**2003**	**2004**	**1979-1981**	**1989-1991**	**1999-2001**	**2002**	**2003**	**2004**
Albania	42	51	66	72	75	78	0.03	0.03	0.03	0.03	0.03	0.33
Algeria	185	428	534	548	553	581	0.14	0.24	0.23	0.22	0.22	2.47
Bosnia and Herzegovina	-	-	35	34	32	36	-	-	0.01	0.01	0.01	0.16
Croatia	-	-	181	192	185	150	-	-	0.08	0.08	0.07	0.64
Cyprus	35	66	102	103	102	109	0.03	0.04	0.04	0.04	0.04	0.46
Egypt	440	754	1,379	1,442	1,445	1,437	0.32	0.42	0.59	0.58	0.57	6.11
France	5,423	5,767	6,538	6,521	6,516	6,255	3.98	3.21	2.79	2.63	2.57	26.6
Greece	525	528	497	493	484	477	0.39	0.29	0.21	0.2	0.19	2.03
Israel	186	236	457	541	520	610	0.14	0.13	0.19	0.22	0.21	2.6
Italy	3,514	3,924	4,128	4,183	4,224	4,079	2.58	2.19	1.76	1.69	1.67	17.34
Libya	142	132	148	142	142	142	0.1	0.07	0.06	0.06	0.06	0.6
Malta	8	15	19	20	20	19	0.01	0.01	0.01	0.01	0.01	0.08
Morocco	248	447	583	618	598	599	0.18	0.25	0.25	0.25	0.24	2.55
Serbia and Montenegro	-	-	912	785	760	810	-	-	0.39	0.32	0.30	3.44
Slovenia	-	-	183	172	208	180	-	-	0.08	0.07	0.08	0.77
Spain	2,601	3,459	4,955	5,248	5,442	5,531	1.91	1.93	2.11	2.12	2.15	23.52
Syria	172	219	344	367	368	391	0.13	0.12	0.15	0.15	0.15	1.66
Tunisia	97	146	244	249	250	245	0.07	0.08	0.1	0.1	0.1	1.04
Turkey	714	1,148	1,352	1,376	1,348	1,583	0.52	0.64	0.58	0.56	0.53	6.73
TOTAL	**14,332**	**17,320**	**22,657**	**23,106**	**23,272**	**23,312**	**10.53**	**9.65**	**9.66**	**9.34**	**9.2**	**99.13**

Source: *Food and Agriculture Organization of the United Nations.*

2.1.2. Meat production according to the origin of the livestock

In Mediterranean Arc countries the production of pork is predominant, with 7,426,370 tonnes. This production accounts for 32.7 % of the total of meat produced. Next in quantity produced is chicken, with 6,150,770 tonnes and 27 % of the total, and beef with 5,110,570 tonnes, accounting for 22.5 % of the total. The remainder corresponds to sheep/goat meat, 1,609,930 tonnes (7 %); turkey, 1,133,550 tonnes (5 %) and other meats. In terms of absolute production, horse meat is the lowest. The NCP meat item corresponds to meats that are not classified in the other items (game meat, among others).

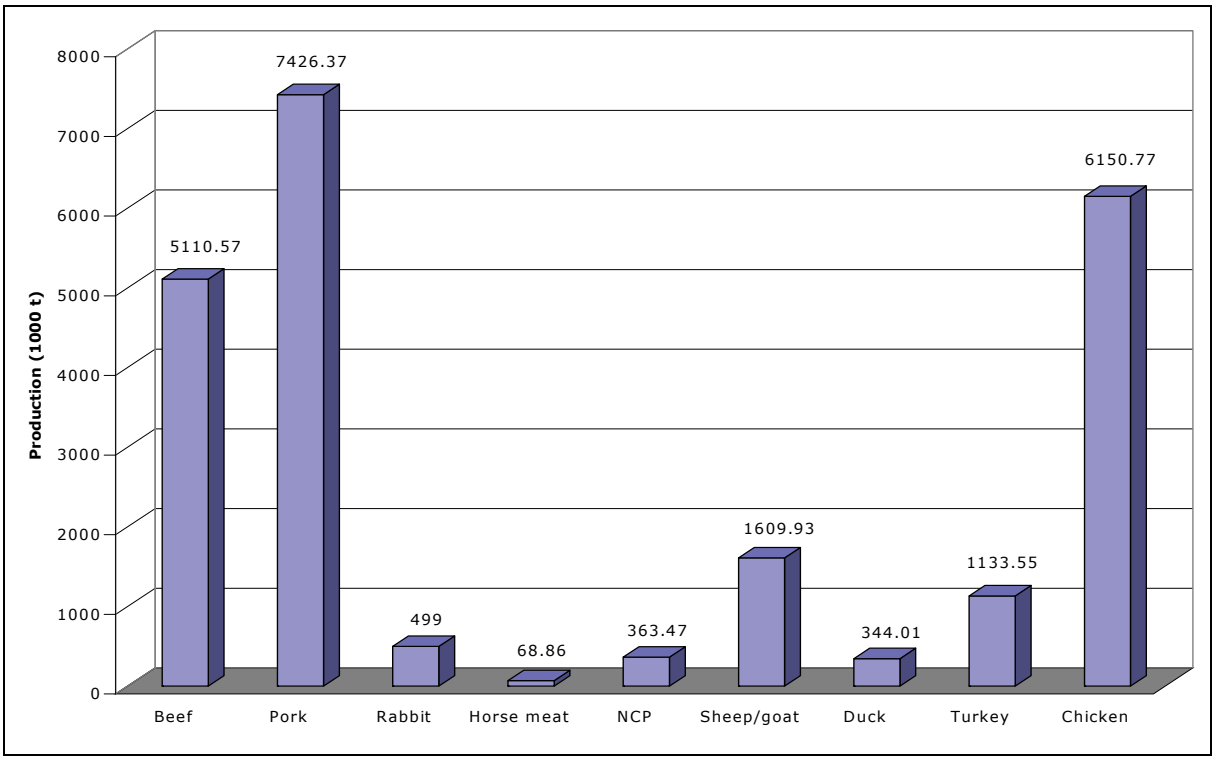


Figure 2.2: Total production of meat in the Mediterranean Arc countries, according to origin of livestock (2004).
Source: *Food and Agriculture Organization of the United Nations.*

The differences between the countries and the meat that each one produces are clear, as can be seen in Table 2.2. Beef, sheep/goat meat, and chicken are produced in all MAP countries. In the case of beef, the largest producers are France and Italy. In general, European countries produce more pork than non-European countries. With regard to the production of rabbit meat and chicken, Spain is the largest producer. In terms of horsemeat, Italy stands out with 45,000 tonnes, accounting for 65.3 % of total production. With regard to sheep/goat meat, the principal producers are Turkey, Spain and Syria. Duck meat is produced mainly in France, as is turkey meat.

Table 2.2: Production of meat in Mediterranean Arc countries in 2004, according to origin of livestock (1,000 t).

Country/livestock	Beef	Pork	Rabbit	Horse meat	NCP	Sheep/ Goat meat	Duck	Turkey	Chicken	TOTAL
Albania	39.6	10.1	0	0	0.1	21.4	0	0	7.2	**78.4**
Algeria	125	0.13	7	0.43	3.4	177.35	0	14.91	253	**581.2**
Bosnia and Herzegovina	16.26	8.2	0	0	0	1.53	1.2	2.3	7	**36.5**
Croatia	31.51	61	0.68	3	0.1	2.43	1.47	11.36	38.5	**150**
Cyprus	4.2	54	0.83	0	0.82	13.1	0.2	1.19	35	**109**
Egypt	593.83	1.54	69.84	0.23	62.7	57.36	81.34	10.5	559.5	**1,437**
France	1,565.49	2,292.57	85.2	6.86	201	128.8	244.9	624.4	1106	**6,255.22**
Greece	75	134.5	5	2.7	1	125	0.27	2.1	132	**477.6**
Israel	83.04	18.03	0	0	0.08	7.7	4.82	115	381.87	**610.5**
Italy	1,151.45	1,588.66	222	45	26	62.85	0	279.36	703.55	**4,078.87**
Lebanon	52.5	1.32	0	0	0	17.44	0.61	0	130	**201.9**
Libya	6.3	0	0	0	3.7	33.37	0	0	98.8	**142**
Malta	1.29	8.47	1.35	0.04	0	0.14	0	0.15	7.4	**18.8**
Morocco	148	0.6	0	1.9	45	124	0	0	280	**599.5**
Serbia and Montenegro	161	538.5	0.03	1.03	1.70	20.58	9.90	10.70	66.46	**161**
Slovenia	46.9	71.3	0	0.33	0.15	1.1	4.6	8.4	47	**180**
Spain	702.33	3,175.63	106.61	5.97	6.5	244.84	0	20.59	1,268.28	**5,530.75**
Syria	47.52	0	0.45	0	2.75	212.12	0.19	4.69	123.3	**391**
Tunisia	53.4	0.15	0	0.45	9.31	61.4	0	25	95.6	**245**
Turkey	366.95	0.17	0.04	1.95	0.86	318	4.41	13.6	876.77	**1,583**
TOTAL	**5,271.57**	**7,426.37**	**499**	**68.86**	**363.47**	**1,609.93**	**344.01**	**1,133.55**	**6,150.77**	**22,867.24**

Source: *Food and Agriculture Organization of the United Nations.*

The figure below shows the distribution of production among the different countries for the most commonly produced types of meat: Pork, chicken, beef and sheep/goat.

Pork production is prevalent above all in three countries: Spain, the principal producer, France and Italy. This type of meat is not produced in Libya or Syria. The remaining Mediterranean Arc countries only produce 5 % of the total.

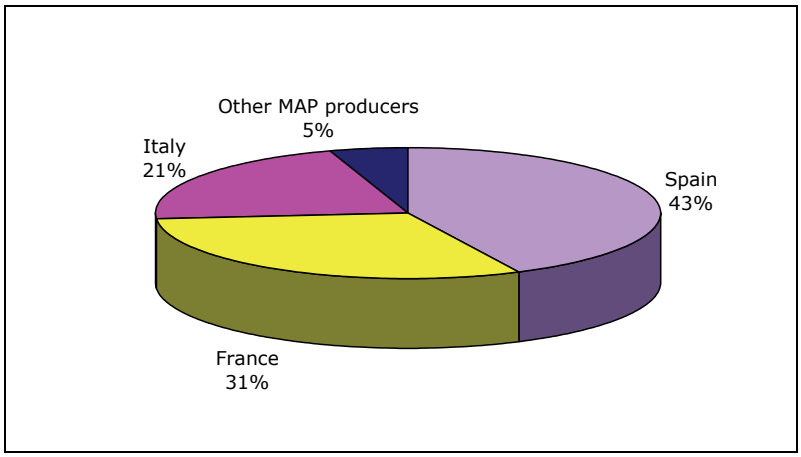


Figure 2.3: Distribution of pork production in Mediterranean Arc countries.

Source: *Food and Agriculture Organization of the United Nations.*

The second type of meat in terms of the quantity produced in 2004 was chicken, with a total of 6,150,770 tonnes. The principal producers are Spain, France, Turkey, Italy and Egypt. In the graphic, the item “Other MAP producers” encompasses the remaining eleven countries, whose production is equal to or less than 132,000 tonnes/year.

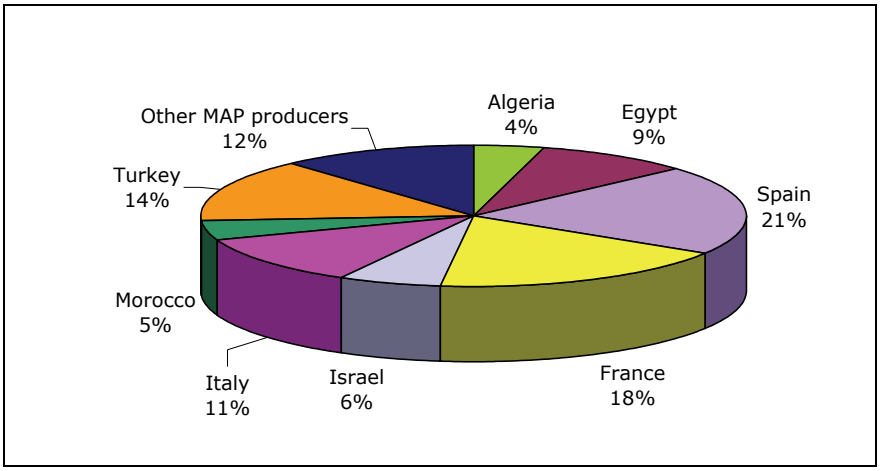


Figure 2.4: Distribution of chicken production in Mediterranean Arc countries.

Source: *Food and Agriculture Organization of the United Nations.*

The principal producer of beef is France, with 30 % of the total, followed by Italy, Spain, Egypt and Turkey. In the graphic, the item “Other MAP producers” encompasses the remaining eleven countries, whose production is equal to or less than 75,000 tonnes/year.

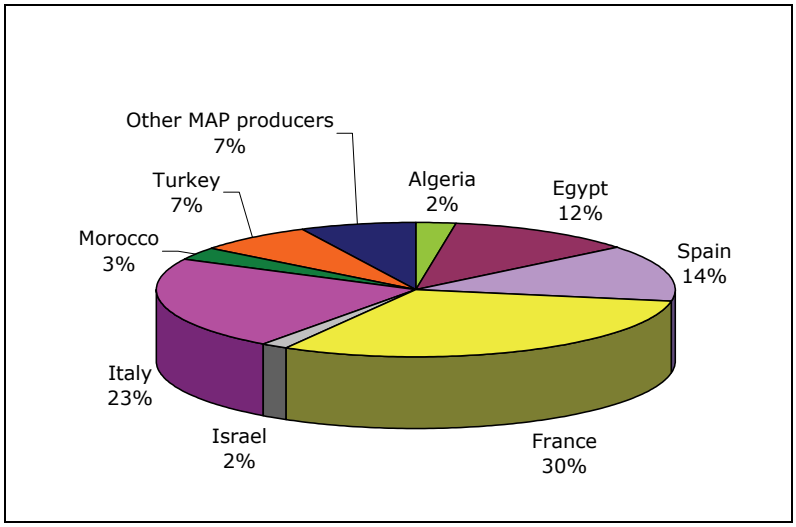


Figure 2.5: Distribution of beef production in Mediterranean Arc countries.
Source: *Food and Agriculture Organization of the United Nations.*

With regard to the production of sheep/goat meat, the principal producers are Turkey, Spain and Syria. In the graphic, the item "Other MAP producers" encompasses the remaining nine countries, whose nfeproduction is equal to or less than 33,370 tonnes/year.

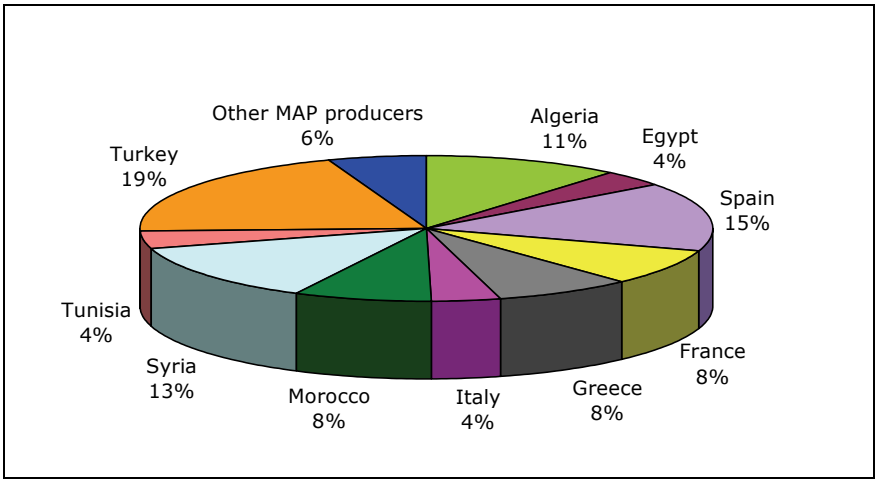


Figure 2.6: Distribution of sheep/goat meat production in Mediterranean Arc countries.
Source: *Food and Agriculture Organization of the United Nations.*

2.1.3. Meat consumption in Mediterranean Arc countries

The total consumption of meat in Mediterranean Arc countries also differs greatly from one country to another, according to population, the quantity produced and the diet of each country.

Table 2.3 shows the data on consumption per country and type of meat. It can be seen that the principal consumers (France, Italy, Spain, Turkey and Egypt) are also the principal producers. It should be pointed out that Italy, the third-largest producer, is nevertheless, the second in terms of consumption. Figure 2.7 shows the distribution in percentages of total meat consumption in the Mediterranean Arc countries.

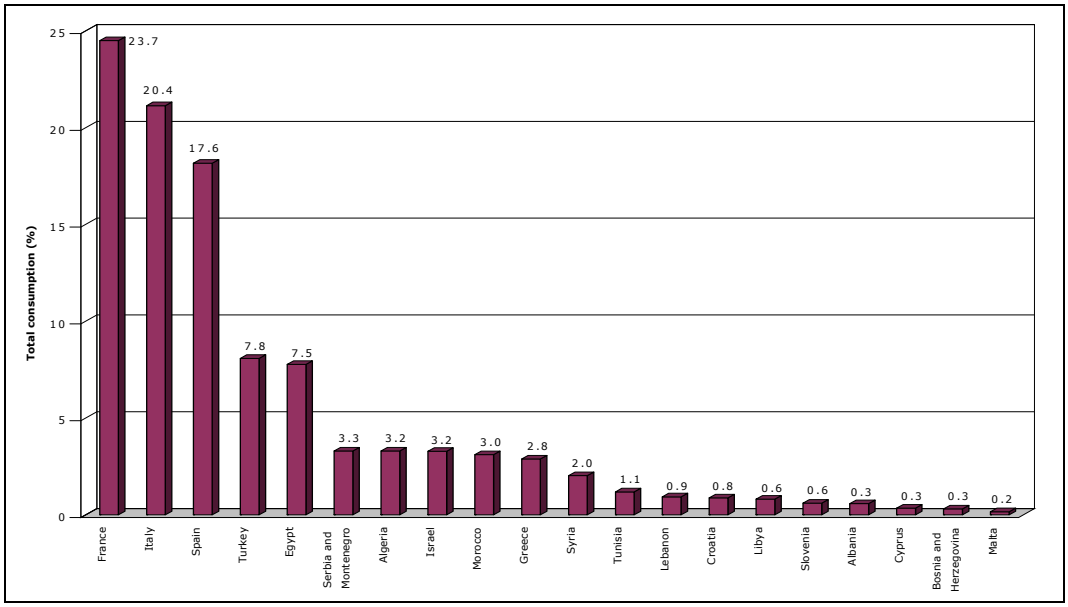


Figure 2.7: Distribution of meat consumption for Mediterranean Arc countries in 2004 (%).

Source: *Food and Agriculture Organization of the United Nations.*

Comparing the totals for meat produced in each country with the totals for meat consumed, it is possible to obtain an idea of the degree of self-sufficiency in each one of them, although the specific situation for each country will be discussed in the following section of this chapter. Thus, this comparison is made below in Figures 2.8 and 2.9, where both magnitudes are expressed in 1,000 tonnes. The two graphs have been separated in order to facilitate comprehension, establishing a division between those countries whose production is either higher or lower than 500,000 tonnes. Thus, it can be seen that the countries that produce more than they consume are Spain, France, Turkey, Cyprus, Slovenia, Lebanon and Tunisia.

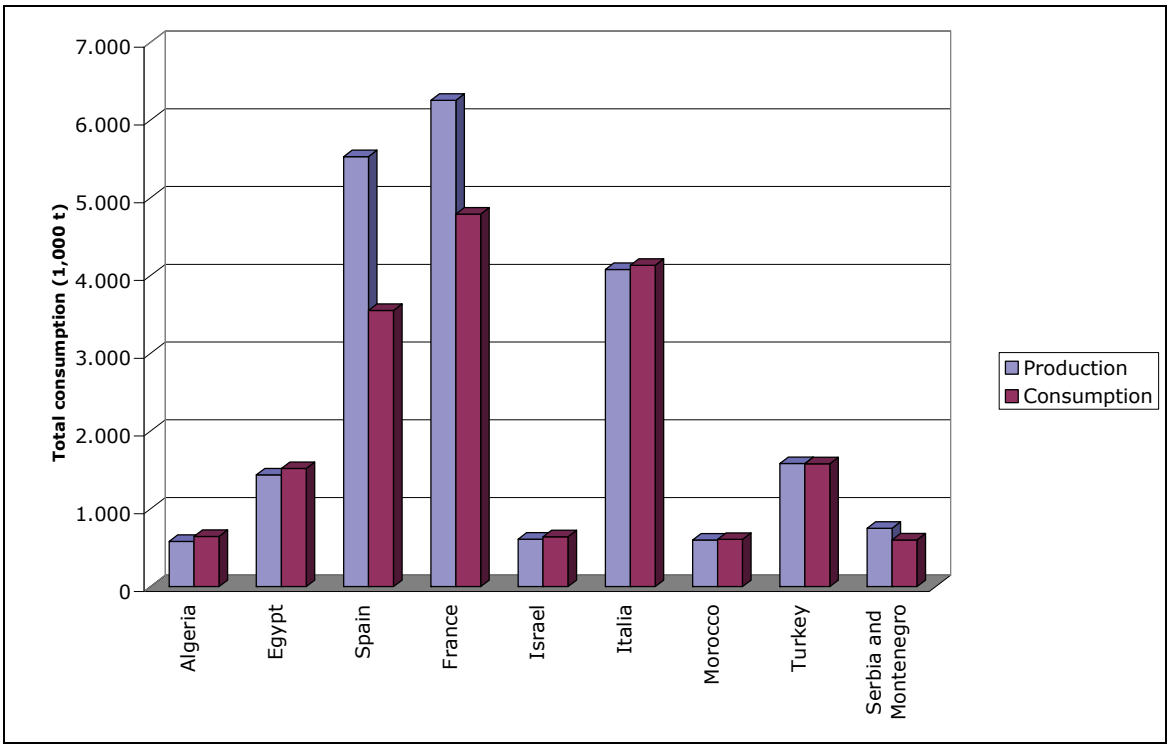


Figure 2.8: Balance of production/consumption in Mediterranean Arc countries, whose production is greater than 500,000 tonnes (2004).

Source: *Food and Agriculture Organization of the United Nations.*

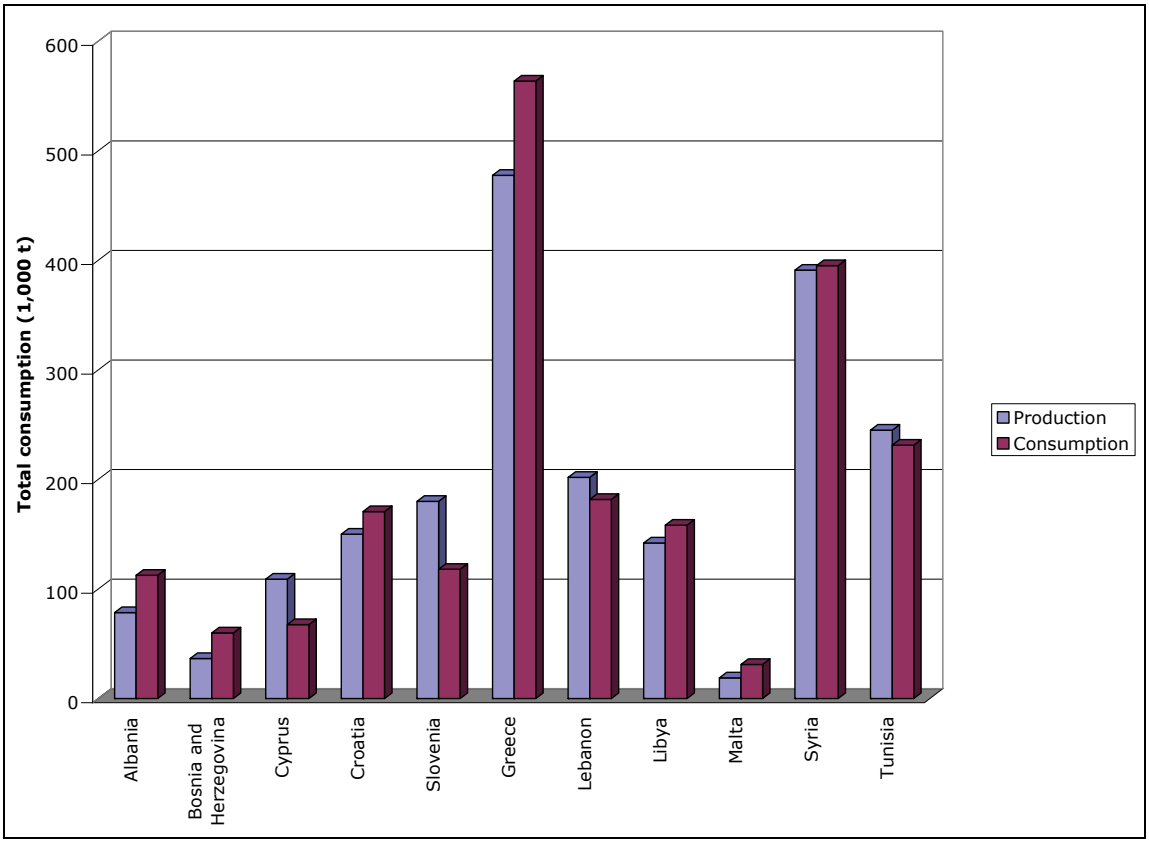


Figure 2.9: Balance of production/consumption in Mediterranean Arc countries, whose production is lower than 500,000 tonnes (2004).

Source: *Food and Agriculture Organization of the United Nations.*

Table 2.3: Total consumption of meat according to livestock and in Mediterranean Arc countries for 2004 (1,000 t).

Country/product	Beef (cattle and buffalo)	Pork	Rabbit meat	Horse meat	Sheep/goat meat	Duck, goose or guinea fowl	Turkey meat	Chicken	NCP or other meats	TOTAL
Albania	44.08	18.64	0	0	21.66	0.01	1.03	26.97	0.04	**112.43**
Algeria	178.33	0.33	7	0.43	187.94	0	13.92	253.8	3.11	**644.86**
Bosnia and Herzegovina	21	14.92	0	0.13	1.75	1.2	2.8	18	0.03	**59.83**
Croatia	34.6	77.86	0.35	3.21	4.71	1.52	11.14	37.2	0	**170.59**
Cyprus	4.36	16.75	0.83	0	13.78	0.23	1.22	29.58	0.78	**67.53**
Egypt	675.81	1.65	69.83	0.23	57.51	81.29	10.52	559.4	62.7	**1,518.94**
France	1,178.08	1,818.5	82.83	25.38	201.71	235.23	402.94	627.66	218.63	**4,790.96**
Greece	105.33	132.61	6.04	2.43	136.94	0.75	18.37	159.51	1.59	**563.57**
Italy	1,397.63	1,432.54	220.14	65.95	82.31	1.38	239.83	662.7	30.67	**4,133.15**
Israel	127.61	22.98	0	0	8.06	4.76	110.95	366.56	0	**640.92**
Lebanon	59.88	7.32	0	0	14.92	0.34	0.21	99.05	0	**181.72**
Libya	7.95	0.07	0	0	47.55	0.01	0	98.8	3.75	**158.13**
Malta	6.74	12.29	1.46	0.05	0.51	0.1	0.53	9.39	0.07	**31.14**
Morocco	151.84	5.61	0	1.9	122.83	0	1.3	281.43	43.1	**608.01**
Serbia and Montenegro	123.92	410.57	0	0.61	21.13	9.85	11.63	84.98	1.86	**664.55**
Slovenia	23.55	43.17	0.01	0.38	1.14	4.78	9.1	35.7	0.14	**117.97**
Spain	465.04	1,352.55	102.92	5.75	239.16	5.27	35.66	1,332.63	13.53	**3,552.51**
Syria	46.74	0.43	0.45	0	215.77	0.19	4.69	124.2	2.68	**395.15**
Tunisia	40.63	0	0	0.45	61.08	0.03	24.96	95.19	8.91	**231.25**
Turkey	353.5	4.7	0.04	1.95	318.07	4.41	12.81	883.68	0.65	**1,579.81**
TOTAL	**5,046.62**	**5,373.49**	**491.9**	**108.85**	**1,758.53**	**351.35**	**913.61**	**5,786.43**	**392.24**	**20,223.02**

Source: *Food and Agriculture Organization of the United Nations.*

Nevertheless, if we compare the consumption of meat in each country expressed as the quantity consumed per person per day, the importance of meat in the diet becomes apparent. Thus Figure 2.10 shows that the country in which most meat is consumed per person per day is Israel, with a daily intake of 267.7 grams, followed by Spain, 236.7 grams and Cyprus with 229 grams. The countries in which least meat is consumed are Algeria, with 54.6 grams per person per day, Morocco, with 53.6 grams and Bosnia and Herzegovina, with 39.2.

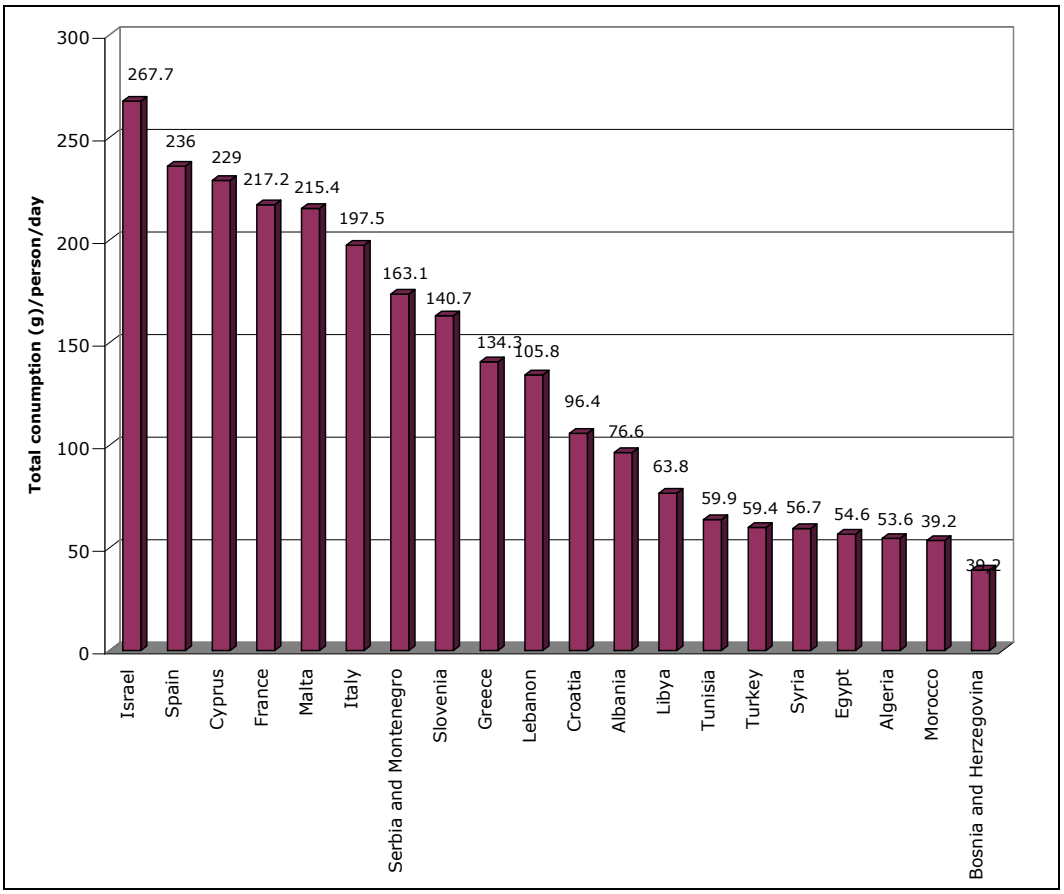


Figure 2.10: Meat consumption in grams per person per day for Mediterranean Arc countries (2004).
Source: *Food and Agriculture Organization of the United Nations.*

2.1.4. Meat trade in Mediterranean Arc countries

As mentioned above, in the majority of Mediterranean Arc countries production is lower than consumption; hence these countries must resort to imports to satisfy demand in their markets.

Below the foreign meat trade for all the countries is analysed; this will be studied in greater detail in the next section of this chapter. Table 2.4 shows meat imports and exports, in both quantity (in tonnes) and value (in millions of dollars) along with the net trade, which is obtained by the difference between the quantity imported and the quantity exported.

It can be seen that only four countries have a positive net trade balance (i.e. they export more meat than they import): France, Spain, Tunisia and Slovenia. The remaining countries import higher quantities than they export. It should be pointed out that, despite producing greater quantities than they consume, three countries, Cyprus, Lebanon and Turkey, still import more meat than they export.

Figures 2.11 A and 2.12 show the imports and exports of each of the MAP countries, separating those countries that import and export greater quantities from the rest.

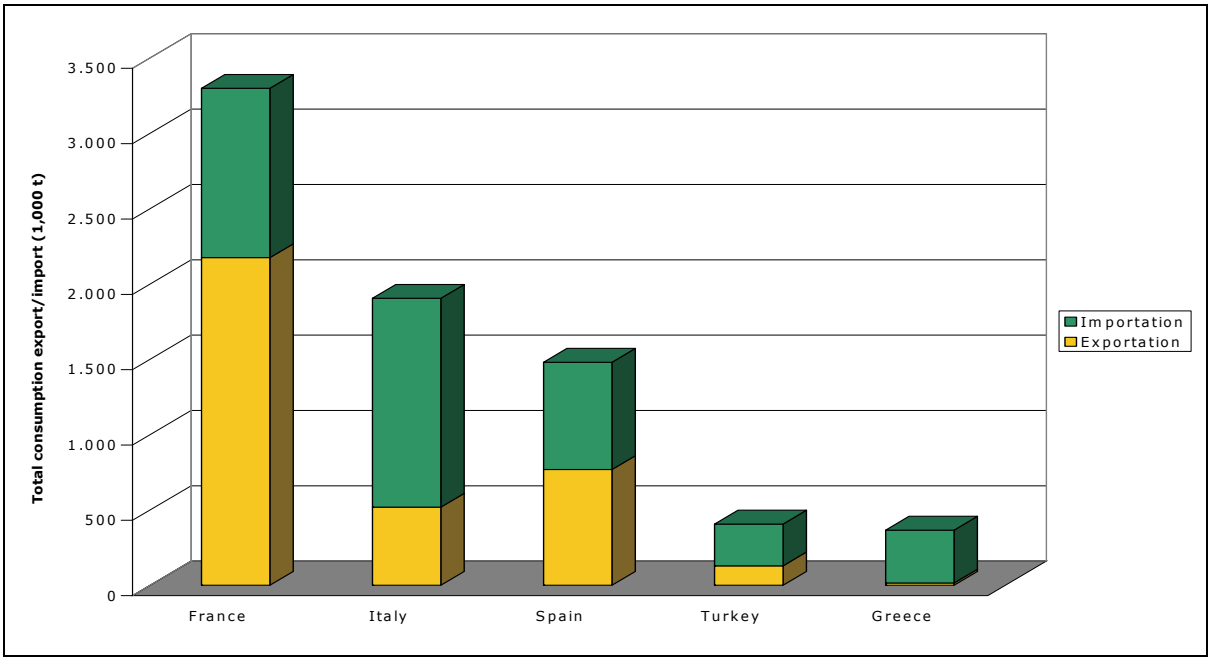


Figure 2.11: Meat imports and exports for Mediterranean Arc countries.
Source: *Food and Agriculture Organization of the United Nations.*

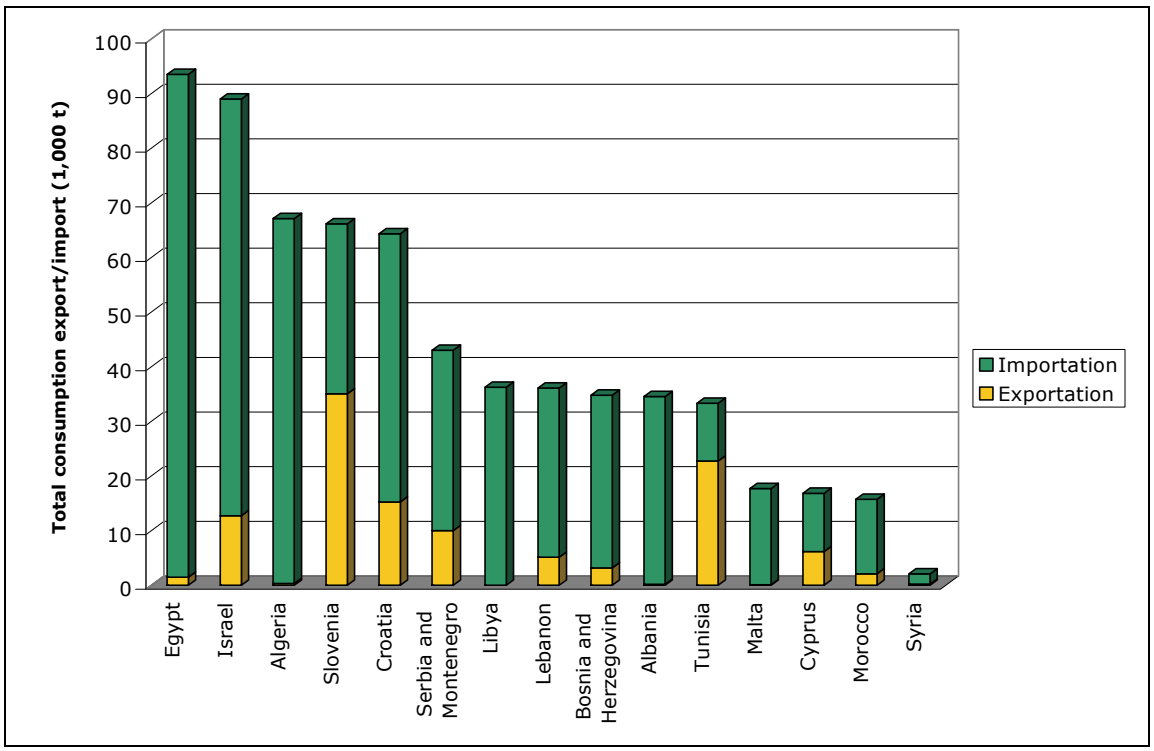


Figure 2.12: Meat imports and exports for Mediterranean Arc countries.
Source: *Food and Agriculture Organization of the United Nations.*

Table 2.4: Meat trade in Mediterranean Arc countries (2204).

Country:	Quantity exported (1,000 t)	Value of exports (millions €)	Quantity imported (1,000 t)	Value of import (million €)	Net trade (1,000 t)
Albania	0.17	0.03	34.38	32.32	-34.21
Algeria	0.34	1.03	66.77	132.32	-66.43
Bosnia and Herzegovina	3.18	3.75	31.61	42.85	-28.43
Croatia	15.24	35.06	49.09	94.16	-33.85
Cyprus	6.14	5.66	10.69	23.67	-4.55
Egypt	1.48	1.02	92.03	134.69	-90.55
France	2,174.49	1,189.37	1123.83	1,058.54	1,050.66
Greece	15.16	23.96	351.05	755.76	-335.89
Israel	12.72	36.83	76.27	168.51	-63.55
Italy	518.95	1,274.48	1,386.33	307.42	-867.38
Lebanon	5.12	4.19	30.96	58.46	-25.84
Libya	0	0	36.24	24.73	-36.24
Malta	0.11	0.54	17.58	44.12	-17.47
Morocco	2.09	1.33	13.63	4.93	-11.54
Serbia and Montenegro	10.11	-	32.94	-	-11.54
Slovenia	35.05	67.90	31.09	64.45	3.96
Spain	768.16	1,630.07	712.59	884.62	55.57
Syria	0.2	0.26	1.87	1.36	-1.67
Tunisia	22.73	7.86	10.58	20.64	12.15
Turkey	129.5	35.18	277.31	35.35	-147.81

Source: *Food and Agriculture Organization of the United Nations.*

2.2. SPECIFIC SITUATION OF THE MEAT SECTOR IN THE MEDITERRANEAN ARC COUNTRIES

ALBANIA

POPULATION[04] (1,000): 3,194
AREA: 28,750 km^2
INCOME PER CAPITA[02] (€): 937
MEAT PRODUCTION (1,000 t): 78.4
MEAT CONSUMPTION (1,000 t): 112.43

[02]: 2002; [04]: 2004

Albania has borders with Greece, Montenegro, Serbia and Macedonia. Its income per capita is €937, and this has been increasing over the last 10 years. The agricultural income per capita is €722.

With regard to resources, Albania has 445,000 ha of pasture land. With regard to livestock, the census reflects 700,000 head of cattle, and more than 2.5 million sheep and goats.

Production in Albania has been increasing over the past five years, rising from 67,300 t in 2000 to 78,400 t in 2004. Worthy of mention is beef production, which accounts for more than half the total, with 39,600 tonnes. That of sheep/goat meat has been more constant over recent years, and accounts for a quarter of the total, some 21,400 tonnes. The following table shows the quantity of meat produced in Albania according to type and expressed in 1,000 t.

Quantity of meat produced in Albania (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	35.9	35.3	37.6	40	39.6
Pork	7.8	7.8	8.6	8.6	10.1
Sheep/goat meat	19.5	19.5	19.5	19.5	21.4
Chicken	4	4	6	7	7.2
Other meats	0.1	0.1	0.1	0.1	0.1
TOTAL	**67.3**	**66.7**	**71.8**	**75.2**	**78.4**

Source: *Food and Agriculture Organization of the United Nations.*

With regard to the consumption of meat, this has also increased in recent years. The meats with the highest consumption in Albania are beef, followed by chicken and sheep/goat meat. Consumption of other types is very low. The table below shows the evolution of this over the past five years, distinguished by type.

Meat consumption in Albania (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	33	32.8	37	38.9	37.8
Pork	12.1	19	20.3	22.6	16
Rabbit meat	0.01	0	0	0	0
Horse meat	0	0	0	0.01	0
Sheep/goat meat	17.4	17.2	17.3	17.2	18.6
Duck, goose or guinea fowl	0	0	0	0	0.01
Turkey meat	1.48	0.57	1.09	1.1	0.88
Chicken	14.9	22	32.8	26.7	23.1
Other meats	0.24	0.12	0.19	0.06	0.03
TOTAL	**79.1**	**91.7**	**109**	**107**	**96.4**

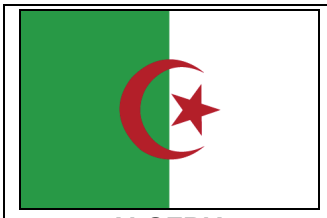
Source: *Food and Agriculture Organization of the United Nations.*

Regarding the meat trade, Albania is essentially an importing country, with 34,380 tonnes of meat imported versus 170 exported. With regard to the quantity of imports, chicken, is the most important. The total value of meat exports was €29,325, while the value of imports in 2004 was in excess of €32.2 million, of which over €14.5 million corresponded to chicken and almost €10.2 million to pork.

Meat trade in Albania for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.02	4.46	-4.44
Pork	0	8.61	-8.61
Sheep/goat meat	0	0.38	-0.38
Duck, goose or guinea fowl	0	0.01	-0.01
Turkey meat	0	1.03	-1.03
Chicken	0.06	19.86	-19.8
Other meats	0.09	0.03	0.06
TOTAL	**0.17**	**34.38**	**-34.21**

Source: *Food and Agriculture Organization of the United Nations.*

 **ALGERIA**	POPULATION[04] (1,000): 32,339
	AREA: 2,381,740 km^2
	INCOME PER CAPITA[02] (€): 1,220
	MEAT PRODUCTION (1,000 t): 581.2
	MEAT CONSUMPTION (1,000 t): 644.86

[02]: 2002; [04]: 2004

Algeria has borders with Morocco, Mauritania, Mali, Niger, Libya and Tunisia. Its income per capita, which has been relatively stable over the last 10 years, is €1,220. The agricultural income per capita is €518.

With regard to resources, Algeria has over 31,000,000 ha of pasture land. With regard to the livestock census, it has over 1.5 million head of cattle and buffaloes, and over 20.5 million sheep and goats.

Over the past five years total meat production in Algeria has fluctuated, having finally increased from 2000 (563,700 t) up until 2005 (581,200 t). The production of beef has fallen, while that of chicken and turkey has risen, the increase in this type of meat over the past year having been notable. The greatest productions are those of chicken, with 253.000 tonnes, accounting for over 40 % of the total quantity produced, followed by sheep/goat meat and beef. The following table shows the quantity of meat produced in Algeria according to type and expressed in 1,000 t.

Quantity of meat produced in Algeria (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	132.6	105	116	121	125
Pork	0.13	0.13	0.13	0.13	0.13
Rabbit meat	7	7	7	7	7
Horse meat	0.43	0.43	0.43	0.43	0.43
Sheep/goat meat	176.4	177.4	177.4	177.4	177.4
Turkey meat	4.02	5.82	1.87	5	14.91
Chicken	240	236	243	250	253
Other meats	3.2	3.4	3.4	3.4	3.4
TOTAL	**563.7**	**535.1**	**549.2**	**564.3**	**581.2**

Source: *Food and Agriculture Organization of the United Nations.*

On the other hand, the total consumption of meat over the last five years has diminished, with the decrease in consumption of beef being especially pronounced, while the consumption of other meats, such as chicken, horse meat and rabbit, has been virtually constant, and that of turkey has increased. In 2004, total consumption was 644,860 tonnes. In greater detail, chicken consumption accounts for almost 40 %, with 21.5 grams per person per day, followed by sheep meat with 15 g per person per day (29.1 % of the total) and beef, with 15.1 grams per person per day (27.6 % of the total).

Meat consumption in Algeria (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	24.7	9.81	11.9	14.5	15.1
Pork	0.01	0.02	0.02	0.02	0.03
Rabbit meat	0.63	0.62	0.61	0.6	0.59
Horse meat	0.04	0.04	0.04	0.04	0.04
Sheep/goat meat	16.5	15.9	15.8	15.5	15.9
Turkey meat	0.36	0.52	0.16	0.43	1.18
Chicken	21.8	21	21.4	21.7	21.5
Other meats	0.29	0.3	0.3	0.29	0.26
TOTAL	**64.3**	**48.2**	**50.1**	**53.1**	**54.6**

Source: *Food and Agriculture Organization of the United Nations.*

Algeria is a country that principally imports meat products. The total value of exports in 2004 reached €1 million, while the value of imports exceeded €131.9 million. With regard to imported products, these are principally beef, which accounts for over 80 %, with 53,770 tonnes, and sheep/goat meat.

Meat trade in Algeria for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.04	53.77	-53.73
Pork	0	0.54	-0.54
Sheep/goat meat	0	11.34	-11.34
Chicken	0.01	1.12	-1.11
Other meats	0.29	0	0.29
TOTAL	**0.34**	**66.77**	**-66.43**

Source: *Food and Agriculture Organization of the United Nations.*

BOSNIA & HERZEGOVINA

POPULATION[04] (1,000): 4,186
AREA: 51,129 km^2
INCOME PER CAPITA[02] (€): 1,228
MEAT PRODUCTION (1,000 t): 36.5
MEAT CONSUMPTION (1,000 t): 59.83

[02]: 2002; [04]: 2004

Bosnia and Herzegovina is located between Croatia, Serbia and Montenegro. Its income per capita is €1,228, while its agricultural income per capita is €3,190.

This country has over 1,000,000 ha of pasture land, almost half a million head of bovine livestock, and 670,000 head of goats and sheep.

Over the last five years the production of beef and chicken has increased, especially the latter in 2004. Pork production has decreased progressively, as has that of sheep/goat meat over the last year. The production of the remaining types of meat has remained relatively constant. As can be seen in the following table, despite the increases and decreases, over the last five years total meat production has ultimately increased.

Quantity of meat produced in Bosnia & Herzegovina (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	12.5	13	13	13	16.3
Pork	10.8	11	10	8.2	8.2
Sheep/goat meat	2.7	2.7	2.7	2.7	1.53
Duck, goose or guinea fowl	1.2	1.2	1.2	1.2	1.2
Turkey meat	2.2	2.2	2.2	2.2	2.3
Chicken	5	5	5	5	7
TOTAL	**34.4**	**35.1**	**34.1**	**32.3**	**36.5**

Source: *Food and Agriculture Organization of the United Nations.*

With regard to the consumption of meat, the total was 59,830 tonnes. This total, which increased between 2000 and 2002, has fallen over the last two years. The meats with the highest consumption are beef and chicken, which jointly account for over 65 % of the total. Nevertheless, pork consumption has fallen by almost half. The table below shows meat consumption according to its origin, expressed in grams per person per day.

Meat consumption in Bosnia and Herzegovina (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	15.4	20.3	21.5	18.7	13.7
Pork	18.8	23	18.7	11.1	9.77
Horse meat	0	0	0.05	0.04	0.09
Sheep/goat meat	1.89	1.99	1.76	1.94	1.15
Duck, goose or guinea fowl	0.83	0.81	0.8	0.79	0.79
Turkey meat	1.71	1.68	1.63	2.08	1.83
Chicken	9.58	10.3	14	10.1	11.8
Other meats	0	0	0	0.01	0.02
TOTAL	**48.2**	**58**	**58.5**	**44.8**	**39.2**

Source: *Food and Agriculture Organization of the United Nations.*

Bosnia and Herzegovina imports large quantities of meat: while exports barely exceed €3.6 million, imports total almost €43.9 million. Pork accounts for 43 % of total imports, with 13,570 t, while the second highest import is chicken, with 11,950 t. With regard to exports, pork is the principal item, as can be seen in the following table.

Meat trade in Bosnia and Herzegovina for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.07	5.09	-5.02
Pork	2.5	13.57	-11.07
Horse meat	0	0.13	-0.13
Sheep/goat meat	0.08	0.29	-0.21
Turkey meat	0	0.45	-0.45
Chicken	0.43	11.95	-11.52
Other meats	0.1	0.13	-0.03
TOTAL	**3.18**	**31.61**	**-28.43**

Source: *Food and Agriculture Organization of the United Nations.*

CROATIA

POPULATION[04] (1,000): 4,416
AREA: 56,538 km^2
INCOME PER CAPITA[02] (€): 3,988
MEAT PRODUCTION (1,000 t): 150
MEAT CONSUMPTION (1,000 t): 170.59

[02]: 2002; [04]: 2004

Croatia has borders with Slovenia, Hungary, Serbia and Bosnia-Herzegovina. Its income per capita is €3,988, and the agricultural income per capita is €3,980.

This country has over 1.5 million hectares of pasture land. With regard to the livestock census, it has 444,000 head of cattle and buffaloes, and 673,000 sheep and goats.

With regard to meat production, Croatia produces a wide variety of meat from different types of livestock. Its production has been increasing over the past five years, especially in terms of the production of beef, turkey and chicken, with chicken being the most important item.

Quantity of meat produced in Croatia (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	27.85	25.6	26.6	28.2	31.5
Pork	63.7	63.9	65.1	61.8	61
Rabbit meat	0	0	0	0	0.68
Horse meat	3	3	3	3	3
Sheep/goat meat	2.25	2.22	2.59	3.2	2.43
Duck, goose or guinea fowl	1.47	1.47	1.47	1.47	1.47
Turkey meat	6.6	6.6	7.06	7.51	11.4
Chicken	24.8	25.7	34.6	41.5	38.5
Other meats	0.2	0.1	0.1	0.1	0.1
TOTAL	**129.9**	**129**	**141**	**147**	**150**

Source: *Food and Agriculture Organization of the United Nations.*

The meat with the highest consumption in this country is pork, accounting for 45 % of total, with 48.3 grams per person per day, in spite of a slight decrease over the last two years, followed by chicken and beef. The consumption of turkey meat has practically doubled in recent years.

Meat consumption in Croatia (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	18.8	15	16	17.3	21.5
Pork	56.6	59.4	64.7	63.7	48.3
Rabbit meat	0	0	0	0	0.22
Horse meat	1.85	1.89	2.27	2.09	1.99
Sheep/goat meat	1.68	1.55	1.98	3	2.92
Duck, goose or guinea fowl	0.91	0.95	0.94	0.92	0.94
Turkey meat	3.92	4.15	4.54	4.81	6.91
Chicken	14.5	14.5	20	23.9	23.1
Other meats	0.14	0.07	0.08	0.07	0
TOTAL	**98.4**	**97.5**	**111**	**116**	**106**

Source: *Food and Agriculture Organization of the United Nations.*

In the case of Croatia, more meat is imported than is exported. Last year the value of Croatian meat exports was €35 million, and for imports €94.15 million. The main type of meat exported was chicken, with 6,580 t., accounting for more than 43 % of the total, followed by pork with 4,540 t., and 29.8 % of the total. With regard to imports, pork accounted for over 70 % of the total, 34,590 tonnes out of a total of 49,090 tonnes. Only rabbit, chicken, and other meats showed a positive net trade balance.

Meat trade in Croatia for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	2.82	6.25	-3.43
Pork	4.54	34.59	-30.05
Rabbit meat	0.34	0.01	0.33
Horse meat	0.03	0.24	-0.21
Sheep/goat meat	0.07	2.35	-2.28
Duck, goose or guinea fowl	0.01	0.06	-0.05
Turkey meat	0.49	0.59	-0.1
Chicken	6.58	4.89	1.69
Other meats	0.36	0.11	0.25
TOTAL	**15.24**	**49.09**	**-33.85**

Source: *Food and Agriculture Organization of the United Nations.*

 **CYPRUS**	POPULATION[04] (1,000): 808
	AREA: 9,250 km^2
	INCOME PER CAPITA[02] (€): 10,849
	MEAT PRODUCTION (1,000 t): 109.3
	MEAT CONSUMPTION (1,000 t): 67.53

[02]: 2002; [04]: 2004

Cyprus is one of the islands in the Mediterranean Sea, situated to the south of Turkey. Its income per capita is €10,849, and this has increased significantly over the last 10 years. The agricultural income per capita is €2,960.

It has a total of 4,000 ha of pasture land, with a livestock census of 54,000 head of cattle and buffalo, and 750,000 head of sheep and goat.

With regard to production, worthy of note is the quantity of pork, which accounts for almost half the total and has increased slightly over the last five years. The greatest increase over this period has been noted in sheep/goat meat, rising from 10,520 tonnes in 2000 to 13,100 tonnes in 2004.

Quantity of meat produced in Cyprus (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	4.45	3.9	3.8	4.4	4.2
Pork	52.25	50.7	51.8	53	54
Rabbit meat	0.83	0.84	0.81	0.83	0.83
Sheep/goat meat	10.52	10.99	12.58	12.9	13.1
Duck, goose or guinea fowl	0.24	0.22	0.22	0.2	0.2
Turkey meat	1.15	1.19	1.19	1.19	1.19
Chicken	32.3	33.8	34.8	35	35
Other meats	0.42	0.5	0.5	0.5	0.82
TOTAL	**102.2**	**102.1**	**105.7**	**108**	**109.3**

Source: *Food and Agriculture Organization of the United Nations.*

The total consumption of meat in Cyprus in 2004 exceeded 67,000 tonnes. Chicken is by far the most highly consumed, and accounts for 43 % of the total, with 100.3 g per person per day, followed by pork and sheep/goat meat. The total quantity consumed per person per day, has decreased over the last year, in spite of the rising trend in previous years. This is principally due to a reduction in the consumption of pork.

Meat consumption in Albania (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	21.17	17.75	18.16	20.19	14.78
Pork	128.7	126.3	126.8	125.9	56.8
Rabbit meat	2.9	2.93	2.8	2.84	2.81
Sheep/goat meat	38.17	38.61	43.61	43.41	46.72
Duck, goose or guinea fowl	1.18	1.12	1.1	0.93	0.78
Turkey meat	3.72	2.98	3.57	3.89	4.14
Chicken	91.16	94.04	96.72	97.75	100.3
Other meats	1.4	1.12	1.11	0.27	2.64
TOTAL	**288.4**	**284.8**	**293.9**	**295.2**	**229**

Source: *Food and Agriculture Organization of the United Nations.*

With regard to its meat trade, Cyprus imports more than it exports. The principal item of exported meat is pork, with a total of 5,260 tonnes, accounting for over 85 %, and it is also the type of meat with the greatest volume of imports. The value of meat exports rose to over €5 million, of which practically 80 % were pork exports. The value of meat imports exceeded €23.4 million, with the most important item being beef.

Meat trade in Cyprus for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.47	2.96	-2.49
Pork	5.26	3.58	1.68
Rabbit meat	0	0	0
Horse meat	0	0	0
Sheep/goat meat	0.09	2.04	-1.95
Duck, goose or guinea fowl	0	0.03	-0.03
Turkey meat	0.04	0.07	-0.03
Chicken	0.18	1.95	-1.77
Other meats	0.1	0.06	0.04
TOTAL	**6.14**	**10.69**	**-4.55**

Source: *Food and Agriculture Organization of the United Nations.*

 **EGYPT**	POPULATION[04] (1,000): 73,390
	AREA: 1,001,450 km^2
	INCOME PER CAPITA[02] (€): 916
	MEAT PRODUCTION (1,000 t): 1,437
	MEAT CONSUMPTION (1,000 t): 1,518.9

[02]: 2002; [04]: 2004

Egypt' has borders with Libya, Sudan and Israel. Its income per capita is €916, while its agricultural income per capita is €349.

The livestock census shows more than 7 million head of cattle and buffalo, and over a million sheep and goats.

Over the last five years the quantity of meat produced Egypt has increased, rising from 1,347,000 tonnes in 2000 to 1,437,000 tonnes in 2004. The meat with the greatest production is beef, which with 593,800 t. accounts for 41.3 % of total meat production, and chicken, which with 559,500 t accounts for 39 %. In both cases, production has increased, while in the case of pork and sheep/goat meat it has fallen.

Quantity of meat produced in Egypt (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	543.6	435.3	455.6	515.7	593.8
Pork	3.1	3.1	3.15	3.2	1.54
Rabbit meat	69.6	69.84	69.84	69.84	69.84
Horse meat	0	0	0	0	0.23
Sheep/goat meat	75	77.81	78.13	75.64	57.36
Duck, goose or guinea fowl	81	81.21	81.34	81.34	81.34
Turkey meat	11.75	10	10.5	10.7	10.5
Chicken	513.3	539	547.5	559.5	559.5
Other meats	49.45	61.8	55.8	48.6	62.7
TOTAL	**1,347**	**1,278**	**1,302**	**1,365**	**1,437**

Source: *Food and Agriculture Organization of the United Nations.*

In recent years, meat consumption in Egypt has fallen, especially with regard to beef and sheep/goat meat. The meat with the highest consumption is beef, which with 25.2 grams per person per day accounts for 44.5 % of the total, and chicken, which with 20.9 grams per person per day, represents 36.8 %.

Meat consumption in Egypt (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	29.7	20.9	23	24.1	25.2
Pork	0.13	0.12	0.13	0.12	0.06
Rabbit meat	2.81	2.77	2.71	2.66	2.61
Horse meat	0	0	0	0	0.01
Sheep/goat meat	3.11	3.16	3.06	2.89	2.15
Duck, goose or guinea fowl	3.27	3.22	3.16	3.09	3.03
Turkey meat	0.47	0.4	0.41	0.41	0.39
Chicken	20.9	21.5	21.5	21.3	20.9
Other meats	2	2.45	2.17	1.85	2.34
TOTAL	**62.4**	**54.6**	**56.1**	**56.4**	**56.7**

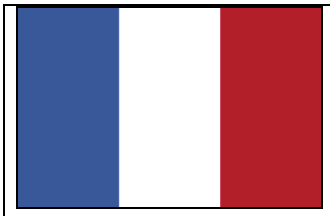
Source: *Food and Agriculture Organization of the United Nations.*

With regard to the meat trade, Egypt is principally an importer. In 2004 the value of exports totalled €1 million, while the volume of imports was €134 million, with over 99 % of this value corresponding to beef. With regard to the quantity of meat, both exported and imported, the principal item was beef. The following table shows the quantity of meat imported into and exported from Egypt.

Meat trade in Egypt for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.84	90.62	-89.78
Pork	0	0.66	-0.66
Rabbit meat	0.01	0	0.01
Sheep/goat meat	0.07	0.22	-0.15
Duck, goose or guinea fowl	0.05	0	0.05
Chicken	0.47	0.36	0.11
Other meats	0.04	0.17	-0.13
TOTAL	**1.48**	**92.03**	**-90.55**

Source: *Food and Agriculture Organization of the United Nations.*



FRANCE

POPULATION[04] (1,000): 60,434
AREA: 547,030 km^2
INCOME PER CAPITA[02] (€): 22,573
MEAT PRODUCTION (1,000 t): 6,255.22
MEAT CONSUMPTION (1,000 t): 4,790.96

[02]: 2002; [04]: 2004

France shares borders with Belgium, Luxembourg, Germany, Switzerland, Italy and Spain. Its income per capita is €22,573, and its agricultural income per capita is €21,904.

This country has more than 10,000,000 ha of pasture land, and the livestock census shows more than 19.5 million head of cattle, and more than 10 million sheep and goats.

France is the largest meat producer of the Mediterranean Arc countries; nevertheless, its production has been dropping since 2001 - from 6,536,000 tonnes to 6,255,220 tonnes in 2004. Pork is the meat with the highest production, with 2,292,570 t., accounting for more than 36 %, followed by beef and chicken.

Quantity of meat produced in France (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	1,527.6	1,566	1,640	1,632	1,565.49
Pork	2,312	2,315.2	2,346	2,339	2,292.57
Rabbit meat	84.6	85.2	83.3	77.8	85.2
Horse meat	10.9	12.2	10.2	8	6.86
Sheep/goat meat	140	140.3	135.1	136.1	128.8
Duck, goose or guinea fowl	239.7	237.5	260.3	247	244.9
Turkey meat	741.1	749.5	697.8	636.2	624.4
Chicken	1,242	1,230.1	1,148	1,132.7	1,106
Other meats	200	200	200	200	201
TOTAL	**6,497.9**	**6,536**	**6,520.7**	**6,408.8**	**6,255.22**

Source: *Food and Agriculture Organization of the United Nations.*

In turn, and in spite of consumption having fallen over the last five years, it is the Mediterranean Arc country that consumes most meat. The meats that have undergone the greatest decreases are beef, pork and chicken. Pork is the meat with the highest consumption, with 82.4 grams per person per day, and accounts for 38 % of total consumption.

Meat consumption in France (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	71.24	75.36	77.2	72.48	53.4
Pork	104	103.5	99.6	104.7	82.4
Rabbit meat	4.01	4.06	3.74	3.47	3.76
Horse meat	1.49	1.65	1.38	1.23	1.15
Sheep/goat meat	11.57	9.44	9.43	9.37	9.14
Duck, goose or guinea fowl	10.58	10.43	11.5	10.82	10.7
Turkey meat	21.08	22.29	20.3	18.96	18.3
Chicken	41.56	43.7	39.7	39.7	28.5
Other meats	9.93	10.43	10.4	10.23	9.91
TOTAL	**275.5**	**280.8**	**273**	**271**	**217**

Source: *Food and Agriculture Organization of the United Nations.*

France is a major exporter of meat. The total value of exports in 2004 exceeded €1,189 million, while imports totalled over €1,057.9 million. With regard to the quantities exported, the principal items were pork, with 773,930 t, accounting for 35.6 % of the total, and chicken, with 678,960 t, accounting for 31.2 %. The principal quantities of meat exported once again corresponded to pork and beef. With the exception of horsemeat and especially sheep/goat meat, in the remaining items the balance of trade is positive.

Meat trade in France for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	435.28	282.38	152.9
Pork	773.93	421.58	352.35
Rabbit meat	5.39	3.02	2.37
Horse meat	8.34	26.86	-18.52
Sheep/goat meat	9.58	139.31	-129.73
Duck, goose or guinea fowl	14.71	4.83	9.88
Turkey meat	237.58	15.73	221.85
Chicken	678.96	201.71	477.25
Other meats	10.72	28.41	-17.69
TOTAL	**2,174.49**	**1,123.83**	**1,050.66**

Source: *Food and Agriculture Organization of the United Nations.*

GREECE

POPULATION[04] (1,000): 10,997
AREA: 131,940 km^2
INCOME PER CAPITA[02] (€): 10,383
MEAT PRODUCTION (1,000 t): 477.6
MEAT CONSUMPTION (1,000 t): 563.57

[02]: 2002; [04]: 2004

Greece is bordered to the north by Albania, Macedonia and Bulgaria, and to the east by Turkey. The income per capita of this country is €10,383, and the agricultural income per capita is €5,534.

Greece has over 4.5 million hectares of pasture land. The livestock census shows more than 7 million head of cattle and buffalo, and over a million sheep and goats.

Over the last two years, the production of meat in this country has fallen slightly. The items most affected are pork and chicken. Nevertheless, there has been an increase in the production of beef, and the rest of the items have remained practically constant.

Quantity of meat produced in Greece (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	63.3	59.9	62	61.8	75
Pork	141.4	136.6	139.4	134	134.5
Rabbit meat	5	5	5	5	5
Horse meat	2.7	2.7	2.7	2.7	2.7
Sheep/goat meat	125	122.2	126.1	124	125
Duck, goose or guinea fowl	0.27	0.27	0.27	0.27	0.27
Turkey meat	2.1	2.1	2.1	2.1	2.1
Chicken	152.3	152.6	153.6	132.6	132
Other meats	1	1	1	1	1
TOTAL	**493.1**	**482.4**	**492.1**	**463.4**	**477.6**

Source: *Food and Agriculture Organization of the United Nations.*

Over the past five years the consumption of meat has fallen considerable in Greece, dropping from 284.4 g per person per day in 2000 to 141 g in 2004. The meats that have suffered the greatest reductions in consumption are beef and pork. In 2004 the meat with the highest consumption was chicken, with 39.8 g per person per day, accounting for 28 %, followed by sheep/goat meat and pork.

Meat consumption in Greece (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	110.4	55.4	52.8	52.2	26.3
Pork	89.12	93.6	89.4	76.3	33.1
Rabbit meat	2.07	2.64	1.58	1.82	1.51
Horse meat	0.61	0.61	0.61	0.61	0.61
Sheep/goat meat	34.89	34.4	34	33.9	34.2
Duck, goose or guinea fowl	0.14	0.18	0.19	0.31	0.19
Turkey meat	4.42	6.33	5.04	5.86	4.58
Chicken	42.29	47.3	43.5	44.8	39.8
Other meats	0.49	0.68	0.41	0.93	0.4
TOTAL	**284.4**	**241**	**228**	**217**	**141**

Source: *Food and Agriculture Organization of the United Nations.*

Greece is an importer of meat. The total value of exports in 2004 exceeded €23.4 million, while the value of imports exceeded €755 million. With regard to the quantities exported, chicken accounted for over half the 2004 total, with 8,530 t. Concerning the quantities of meat imported, jointly pork and beef accounted for 78 % of the total.

Meat trade in Greece for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	1.73	105.15	-103.42
Pork	2.77	168.36	-165.59
Rabbit meat	0.01	0.96	-0.95
Sheep/goat meat	0.93	16.36	-15.43
Duck, goose or guinea fowl	0	0.42	-0.42
Turkey meat	0.45	16.15	-15.7
Chicken	8.53	42.33	-33.8
Other meats	0.74	1.32	-0.58
TOTAL	**15.16**	**351.05**	**-335.89**

Source: *Food and Agriculture Organization of the United Nations.*

ISRAEL

POPULATION[04] (1,000): 6,560
AREA: 20,770 km²
INCOME PER CAPITA[02] (€): 12,226
MEAT PRODUCTION (1,000 t): 610.5
MEAT CONSUMPTION (1,000 t): 640.92

[02]: 2002; [04]: 2004

Israel has borders with Lebanon, Syria, Jordan, Egypt, Palestine, and the Gaza Strip. Its income per capita is €12,226, and the agricultural income per capita is €12,118.

With regard to pasture land, it has 142,000 ha. The livestock census shows 390,000 head of cattle, and 458,000 sheep and goats.

Over the last five years, the production of meat in this country has risen progressively. Chicken accounts for over 62 % of production, with 381,900 tonnes, followed by turkey and beef. Those items whose production has diminished over this period are duck, goose, chicken, and above all turkey. For all other items, production has either remained unchange or has increased.

Quantity of meat produced in Israel (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	63.8	62.39	64.36	80.99	83.04
Pork	14.86	15.72	16.48	17.43	18.03
Sheep/goat meat	7.8	7.7	7.7	7.88	7.7
Duck, goose or guinea fowl	5.39	9.44	10.33	7.5	4.82
Turkey meat	137.4	125.2	125	113	115
Chicken	294.5	345.1	353	365.8	381.9
Other meats	0.08	0.08	0.08	0.08	0.08
TOTAL	**523.9**	**565.7**	**577**	**592.7**	**610.5**

Source: *Food and Agriculture Organization of the United Nations.*

Meat consumption in Israel increased between 2000 and 2002, and has since fallen again over the last two years. While consumption of pork and chicken has increased progressively, that of turkey and sheep/goat meat has fallen. The consumption of beef has followed a somewhat more irregular trend, but in the end has fallen. Currently chicken accounts for over half the total consumption.

Meat consumption in Israel (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	63.22	57.87	60.97	65.49	53.3
Pork	6.69	6.95	7.13	7.4	9.6
Sheep/goat meat	4.03	3.99	3.51	3.61	3.37
Duck, goose or guinea fowl	2.27	4.09	4.34	3.07	1.99
Turkey meat	62.28	55.55	54.28	48	46.34
Chicken	129.5	148.7	149.7	151.6	153.1
Other meats	0.02	0	0.02	0	0
TOTAL	**268**	**277.2**	**280**	**279.2**	**267.7**

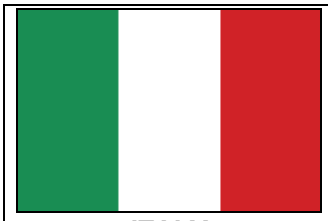
Source: *Food and Agriculture Organization of the United Nations.*

Israel principally exports chicken and imports beef. In 2004, the total volume of exports was €32.8 million, of which more than €24.4 million was for chicken. The total volume of exports was €111.8 million, of which more than €111.2 million was for beef. In terms of quantities, there is a positive net trade balance for duck, turkey, chicken and other meats. In the cases of beef, pork, and sheep/goat meat, more is imported than exported; hence the net trade is negative.

Meat trade in Israel for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.4	45.74	-45.34
Pork	0.16	5.36	-5.2
Rabbit meat	0	0	0
Horse meat	0	0	0
Sheep/goat meat	0	0.38	-0.38
Duck, goose or guinea fowl	0.2	0.01	0.19
Turkey meat	1.21	0	1.21
Chicken	9.17	0.01	9.16
Other meats	0.13	0	0.13
TOTAL	**11.27**	**51.5**	**-40.23**

Source: *Food and Agriculture Organization of the United Nations.*



ITALY

POPULATION[04] (1,000): 57,346
AREA: 301,230 km^2
INCOME PER CAPITA[02] (€): 15,686
MEAT PRODUCTION (1,000 t): 4,078.87
MEAT CONSUMPTION (1,000 t): 4,133.15

[02]: 2002; [04]: 2004

The peninsular of Italy has borders with France, Switzerland, Austria and Slovenia. Its income per capita is €15,686, and its agricultural income per capita is €9,161.

Italy has over 4,000,000 ha of pasture land, over 6.5 million head of cattle, and over 12 million head of sheep and goat.

Between 2000 and 2002, the production of meat increased; it decreased slightly in 2003, to rise again slightly in 2004. Pork production has demonstrated a rising trend throughout this period, while for the remaining items production has either decreased or remained constant. In 2004, pork and beef jointly accounted for over 67 % of production.

Quantity of meat produced in Italy (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	1,153.4	1,134.08	1,135.79	1,128.22	1,151.45
Pork	1,478.5	1,509.64	1,535.9	1,588.66	1,588.66
Rabbit meat	221	222	222	222	222
Horse meat	50.69	63	45.5	45	45
Sheep/goat meat	69.05	66.18	62.86	61.58	62.85
Turkey meat	329.4	344.9	443.6	267.22	279.36
Chicken	763.3	795.5	731.97	685.84	703.55
Other meats	25	25	25	25	26
TOTAL	**4,090.34**	**4,160.3**	**4,202.62**	**4,023.52**	**4,078.87**

Source: *Food and Agriculture Organization of the United Nations.*

Over the last five years, meat consumption in Italy has fallen, and generally that for each of the types of meat has also diminished. The meats with the highest consumption are pork and beef, in that order, which jointly account for over 68 % of total consumption.

Meat consumption in Italy (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	67.45	64.76	65.73	67.89	66.8
Pork	109.5	116.4	117.4	119.5	68.4
Rabbit meat	10.62	10.73	10.62	10.42	10.5
Horse meat	3.24	4.05	3.15	3.1	3.15
Sheep/goat meat	4.19	4.22	3.97	3.93	3.93
Duck, goose or guinea fowl	0.09	0.08	0.1	0.08	0.07
Turkey meat	15.36	13.66	17.36	10.69	11.5
Chicken	36.77	37.02	32.9	31.5	31.7
Other meats	2.08	2.96	2.33	1.32	1.47
TOTAL	**249.3**	**253.9**	**253.6**	**248.4**	**197**

Source: *Food and Agriculture Organization of the United Nations.*

Over the last year, Italy has imported more meat than it has exported. The total volume of exports was €1,274.4 million, of which more than €708 million was for pork. The value of meat exports rose to over €3,219.2 million, of which €1,459.1 million was accounted for by beef, and $1,990.25 million by pork. In terms of quantities, only in the cases of rabbit, turkey and chicken have exports exceeded imports.

Meat trade in Italy for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	177.69	443.07	-265.38
Pork	182.72	814.83	-632.11
Rabbit meat	4.18	2.32	1.86
Horse meat	0.34	22.63	-22.29
Sheep/goat meat	1.01	23.73	-22.72
Duck, goose or guinea fowl	0.1	1.47	-1.37
Turkey meat	63.5	25.36	38.14
Chicken	87.13	45.87	41.26
Other meats	2.28	7.05	-4.77
TOTAL	**518.95**	**1,386.33**	**-867.38**

Source: *Food and Agriculture Organization of the United Nations.*

LEBANON

POPULATION[04] (1,000): 3,708
AREA: 10,400 km^2
INCOME PER CAPITA[02] (€): 2,102
MEAT PRODUCTION (1,000 t): 201.9
MEAT CONSUMPTION (1,000 t): 181.72

[02]: 2002; [04]: 2004

Lebanon has borders with Syria and Israel. While its income per capita is €2,102, its agricultural income per capita is much higher, at €8,779.6.

This country has 16,000 ha of pasture land. With regard to the livestock census, it has 90,000 head of cattle, and 732,000 sheep and goats.

Meat production has increased in Lebanon, increasing from 181,600 tonnes in 2000 to 201,870 in 2004. Nevertheless, in terms of items, the production of beef, and especially that of pork have decreased, while that of sheep/goat meat, duck and chicken have increased. Over the last year, chicken has accounted for 64.4 % of production, with 130,000 tonnes.

Quantity of meat produced in Lebanon (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	57.6	42.9	54.6	52.5	52.5
Pork	2.35	2.2	1.9	1.9	1.32
Sheep/goat meat	8.55	20.25	16.79	17.83	17.44
Duck, goose or guinea fowl	0	0	0	0	0.61
Chicken	113.1	117.4	124.5	127.2	130
TOTAL	**181.6**	**182.75**	**197.79**	**199.43**	**201.87**

Source: *Food and Agriculture Organization of the United Nations.*

Total meat consumption in Lebanon has followed an irregular trend, with increases and decreases over recent years. There have mainly been increases in the consumption of goat/sheep meat and chicken, while consumption for the remaining items has fallen. Chicken accounts for 54.5 % of total consumption, with 73.2 grams per person per day, followed by beef, which, with 44.2 grams per person per day, accounts for 33 % of the total.

Meat consumption in Lebanon (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	48.25	35	47.4	52.2	44.2
Pork	8.41	7.87	8.08	7.59	5.41
Sheep/goat meat	6.04	13	11	11.4	11
Duck, goose or guinea fowl	0.03	0.05	0.02	0	0.25
Turkey meat	0.11	0.23	0.18	0.16	0.16
Chicken	68.94	71	73.8	73.2	73.2
Other meats	0.07	0.09	0.04	0.05	0
TOTAL	**131.9**	**127**	**140**	**145**	**134**

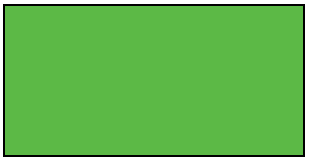
Source: *Food and Agriculture Organization of the United Nations.*

In 2004, Lebanon imported more meat than it exported. The total volume of exports was €4.19 million, of which more than €3 million was for chicken. The total volume of imports was €58.4 million, of which more than €38 million was for beef. In terms of quantities, chicken accounted for almost 63 % of exports, 3,200 t., followed by beef, which accounted for 27 % of exports, with 1,380 t. Imports were principally beef, accounting for 63 %, with 19,500 tonnes.

Meat trade in Lebanon for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	1.38	19.5	-18.12
Pork	0.16	8.21	-8.05
Sheep/goat meat	0.01	0.69	-0.68
Duck, goose or guinea fowl	0.3	0.03	0.27
Turkey meat	0	0.21	-0.21
Chicken	3.2	2.25	0.95
Other meats	0.07	0.07	0
TOTAL	**5.12**	**30.96**	**-25.84**

Source: *Food and Agriculture Organization of the United Nations.*

 **LIBYA**	POPULATION[04] (1,000): 5,659
	AREA: 1,759,540 km^2
	INCOME PER CAPITA[02] (€): 3,801
	MEAT PRODUCTION (1,000 t): 142
	MEAT CONSUMPTION (1,000 t): 158.13

[02]: 2002; [04]: 2004

Libya has borders with six countries: Tunisia, Algeria, Niger, Chad, Sudan and Egypt. Its income per capita is €3,801, while its agricultural income per capita more than doubles that figure, at €7,719.9. It is the largest of the Mediterranean Arc countries, with over 1.5 million square kilometres.

Its resources include 13,300,000 ha of pasture land, and 130,000 head of cattle, and over 5 million head of goats and sheep.

Libya produces no pork, rabbit, horsemeat, duck or turkey. In spite of the increase in 2001, the total meat produced has remained practically constant; only the production of beef has fallen in recent years. The meat with the greatest production in this country is chicken which, with 98,800 tonnes, accounts for almost 70 % of the total.

Quantity of meat produced in Libya (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	8.2	6.3	6.3	6.3	6.3
Sheep/goat meat	33.35	38.3	33.35	33.37	33.37
Chicken	98.54	99.06	98.8	98.8	98.8
Other meats	3.7	3.7	3.5	3.7	3.7
TOTAL	**143.8**	**147.4**	**142**	**142.2**	**142.2**

Source: *Food and Agriculture Organization of the United Nations.*

In recent years, meat consumption in Libya has fallen progressively, dropping from 87.4 grams per person per day in 2000 to 76.6 in 2004. The greatest reduction in consumption has been in beef, which has fallen to practically a quarter of the previous figure. Chicken consumption has also fallen, and to a lesser extent, so has that of the other meats. An increase in consumption of pork, as well as sheep/goat meat has been noted. The meat with the highest consumption is chicken, with 47.8 grams per person per day, and accounting for 62.5 % of total consumption.

Meat consumption in Libya (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	12.9	10.4	3.8	3.59	3.85
Pork	0	0	0.02	0.01	0.03
Sheep/goat meat	20.7	20.3	22.9	17.2	23
Duck, goose or guinea fowl	0	0	0	0.12	0
Chicken	51.9	51.1	51.1	50.1	47.8
Other meats	1.95	2.77	1.76	1.83	1.82
TOTAL	**87.4**	**84.5**	**79.6**	**72.8**	**76.6**

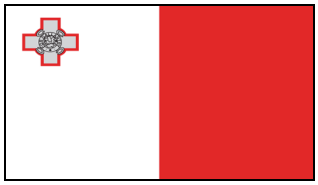
Source: *Food and Agriculture Organization of the United Nations.*

Libya exports no meat; it only imports. In 2004, the total volume of imports was €24.7 million, of which more than €16.4 million was for beef. This item is the highest quantity imported, along with sheep/goat meat; between them they account for over 97 % of total imports to this country.

Meat trade in Libya for2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0	20.22	-20.22
Pork	0	0.71	-0.71
Sheep/goat meat	0	15.28	-15.28
Chicken	0	0.02	-0.02
Other meats	0	0.01	-0.01
TOTAL	**0**	**36.24**	**-36.24**

Source: *Food and Agriculture Organization of the United Nations.*

 **MALTA**	POPULATION[04] (1,000): 396
	AREA: 316 km^2
	INCOME PER CAPITA[02] (€): 7,503
	MEAT PRODUCTION (1,000 t): 18.8
	MEAT CONSUMPTION (1,000 t): 31.14

[02]: 2002; [04]: 2004

The island of Malta is located to the south of Italy. While its income per capita is €7,503, its agricultural income per capita is higher, at €10,263.9.

Malta has 18,000 head of cattle and 20,000 head of sheep and goats.

Between 2000 and 2002 meat production in Malta increased, but has fallen over the last two years. In terms of items, beef and pork production has decreased, while that of chicken has increased and the rest have remained constant. The meat with the highest production is chicken which with 7,400 t, accounts for 39.3 % of the total.

Quantity of meat produced in Malta (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	1.61	1.54	1.64	1.41	1.29
Pork	9.07	9.93	10.4	9.78	8.47
Rabbit meat	1.35	1.35	1.35	1.35	1.35
Horse meat	0.04	0.04	0.04	0.06	0.04
Sheep/goat meat	0.14	0.12	0.12	0.14	0.14
Turkey meat	0.15	0.15	0.29	0.11	0.15
Chicken	6	6.26	6.66	7.41	7.4
TOTAL	**18.4**	**19.4**	**20.5**	**20.3**	**18.8**

Source: *Food and Agriculture Organization of the United Nations.*

Despite fall in 2001, total meat consumption in Malta has increased over the last five years. The consumption of beef, along with that of sheep/goat meat, has fallen, while for the remaining items it has either increased or remained constant. The meat with the highest consumption is pork, with 85 g per person per day, accounting for 39.4 % of the total, followed by chicken with 65 g per person per day and 30.1 %, and beef, which, at 46.6 grams per person per day, accounts for 21.6 %.

Meat consumption in Malta (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	66.87	38.4	60.7	58.9	46.6
Pork	76.58	85.9	82.8	88.7	85
Rabbit meat	9.5	9.46	9.42	9.38	10.1
Horse meat	0.32	0.3	0.31	0.42	0.35
Sheep/goat meat	5.27	6.94	4.49	6.95	3.53
Duck, goose or guinea fowl	0.64	1.25	1.03	1.01	0.69
Turkey meat	2.06	2.97	4.03	3.23	3.67
Chicken	40.62	45.3	48.2	54.5	65
Other meats	0.27	1.65	1.69	0.37	0.48
TOTAL	**202.1**	**192**	**213**	**223**	**215**

Source: *Food and Agriculture Organization of the United Nations.*

The total volume of exports rose to €0.54 million, of which more than €0.52 million was for beef. The total volume of imports was €43.9 million, of which more than €19.7 million was for beef, this being the largest item for both meat imports and exports.

Meat trade in Malta for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.07	6.8	-6.73
Pork	0	5.35	-5.35
Rabbit meat	0	0.11	-0.11
Sheep/goat meat	0.01	0.48	-0.47
Duck, goose or guinea fowl	0	0.09	-0.09
Turkey meat	0	0.39	-0.39
Chicken	0	4.27	-4.27
Other meats	0.03	0.09	-0.06
TOTAL	**0.11**	**17.58**	**-17.47**

Source: *Food and Agriculture Organization of the United Nations.*

MONACO

POPULATION[04] (1.000): 32.1
AREA: 1.95 km^2
INCOME PER CAPITA[05] (€): 19,795
MEAT PRODUCTION[04] (1,000 t): -
MEAT CONSUMPTION[04] (1,000 t): -

[04]: 2004; [05]: 2005

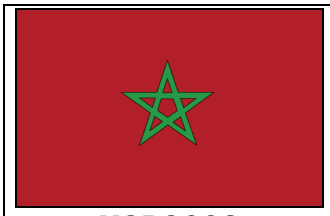
The Monaco national focal point reports that in the principality of Monaco there is no agri-food industry in the animal slaughter and meat product sectors. Nevertheless, there are eight retail butchers-delicatessens and two wholesale butchers in Monegasque territory, as well as seven meat sections in one hypermarket and six supermarkets. Consequently, the Directorate for Environment, Urban Planning and Construction of the Monegasque Department of Facilities, Urban Planning and Environment has no data available concerning the consumption and trade of meat in the country.

Monaco is a small country, with just a small stretch of coastline, which is almost totally encircled by France. Its economy is based on the commercial, financial, and, above all, the tourism sectors.

In recent decades, Monaco's industrial sector has undergone considerable development. The first industries to be set up there were in the flour, beer and chocolate sectors. More recently, close to 200,000 square metres of industrial facilities have been constructed. The small size of the country should be borne in mind, as it greatly increases the cost of land.

Current industry in Monaco is diverse: ranging from the chemical, pharmaceutical and cosmetic industries to plastics, graphic arts, paper, electronics and textiles. Altogether there are approximately 200 businesses. The most important sector is currently that of chemical, pharmaceutical and cosmetic products, although firms engaged in processing plastics and the manufacture of electronic equipment are also significant.

The meat sector in Monaco is very small, as consumption is based mostly on imports.



MOROCCO

POPULATION[04] (1,000): 31,064
AREA: 446,550 km^2
INCOME PER CAPITA[02] (€): 1,067
MEAT PRODUCTION (1,000 t): 599.5
MEAT CONSUMPTION (1,000 t): 608.01

[02]: 2002; [04]: 2004

Morocco has borders with Western Sahara and Algeria. The income per capita of this country is €1,067, and its agricultural income per capita is €532.

This country has 21 million hectares of pasture land. With regard to livestock, it has over 2.5 million head of cattle and almost 22 million head of sheep and goats.

Over the past five years, and in spite of the fall that it underwent in 2003 and 2004, the total production of meat in Morocco has increased. In particular, the production of chicken has increased, while that of sheep/goat meat has fallen. This country produces no rabbit meat, duck or turkey. The meat with the highest production is chicken which, with 280,000 t, accounts for 46.7 % of the total.

Quantity of meat produced in Morocco (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	140	159	170	150	148
Pork	0.6	0.6	0.6	0.6	0.6
Horse meat	2	2	1.9	1.9	1.9
Sheep/goat meat	147	145.5	130	121	124
Chicken	250	255	280	280	280
Other meats	35	35	35	35	45
TOTAL	**574.6**	**597.1**	**617.5**	**588.5**	**599.5**

Source: *Food and Agriculture Organization of the United Nations.*

In the same manner as for production, the total consumption of meat in Morocco increased from 2000 to 2002, to then fall in 2003 and 2004. In this country there is no consumption of duck or rabbit meat. The meat with the highest consumption is chicken, followed by beef and sheep/goat meat. It is in sheep/goat meat where the greatest fall has been noted over the past five years.

Meat consumption in Morocco (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	13.2	14.7	15.5	13.5	13.4
Pork	0.06	0.06	0.06	0.06	0.49
Horse meat	0.19	0.19	0.17	0.17	0.17
Sheep/goat meat	13.8	13.5	11.9	10.9	10.8
Turkey meat	0.08	0.19	0.19	0.13	0.11
Chicken	23.6	23.7	25.6	25.2	24.8
Other meats	3.29	3.24	3.19	3.14	3.8
TOTAL	**54.3**	**55.6**	**56.6**	**53**	**53.6**

Source: *Food and Agriculture Organization of the United Nations.*

Morocco imports more meat than it exports. In 2004 the total value of exports exceeded €1.33 million, while imports totalled €4.9 million. The "other meats" item was that of highest exports, and the greatest quantity imported was that of beef, 48.2 % of the total with 6,590 t, and pork, 5,210 t, accounting for 38.2 %.

Meat trade in Morocco for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.1	6.59	-6.49
Pork	0	5.21	-5.21
Sheep/goat meat	0.01	0.05	-0.04
Turkey meat	0.06	1.35	-1.29
Chicken	0.01	0.42	-0.41
Other meats	1.91	0.01	1.9
TOTAL	**2.09**	**13.63**	**-11.54**

Source: *Food and Agriculture Organization of the United Nations.*

 **SERBIA AND MONTENEGRO**	POPULATION[04] (1.000): 10,519
	AREA: 102,173 km^2
	INCOME PER CAPITA[02] ($): 723
	MEAT PRODUCTION (1,000 t): 599.5
	MEAT CONSUMPTION (1,000 t): 664.55

[02]: 2002; [04]: 2004

MONTENEGRO

The new State of Montenegro, whose administrative capital is Podgorica (formerly known as Titograd, with 169,000 inhabitants) and which has its political headquarters in Cetinje (with a population of around 25,000, and which is the historical capital of the country), came into being by reason of the referendum carried out on 21 May 2006, a plebiscite formulated in accordance with the so-called Belgrade Agreement of February 2002, subjecting to public opinion the continuance, or not, as the State Union of Serbia Montenegro, which had been constituted 4 February 2003. This referendum approved the proposal for the separation of Montenegro, from the State Union of Serbia and Montenegro, with a total of 55.5 % voting in favour (with 86.5 % of the registered electorate voting). The Parliament of this Republic officially proclaimed the independence of Montenegro on 3 June 2006 (Spanish Ministry of Industry, Tourism and Trade, ICEX).

SERBIA

The Republic of Serbia, whose capital is Belgrade, acquired the status of independent State by means of a Parliamentary resolution adopted on 5 June 2006, after the recent dissolution of the Republic of Serbia Montenegro, which had been constituted on 4 February 2003; this dissolution came about as a consequence of the Montenegrin referendum of 21 May 2006, and the proclamation of the independence of Montenegro on 3 June 2006. In accordance with the Belgrade Agreement, ratified by the Republic of Serbia and the Republic of Montenegro, and Article 60 of the Constitutional Charter of the then State Union of Serbia and Montenegro, Serbia now has the status of successor State to the former Republic of Serbia and Montenegro.

Within the Republic of Serbia are the autonomous province of Vojvodina (capital Novi Sad) and the autonomous province of Kosovo, the latter being a protectorate of the UN (UNMIK) in accordance with Resolution 1244 of the UN Security Council, and of which attempts will be made to define the status during the first quarter of 2007 (Spanish Ministry of Industry, Tourism and Trade, ICEX).

Due to the sources available for the study being from 2004, in the sections below the data on the meat sectors of Montenegro and Serbia are described jointly.

Serbia and Montenegro are in the Balkan Peninsula, and have borders to the north with Hungary, to the east with Romania and Bulgaria, to the south with Albania and Macedonia, and to the west with Croatia and Bosnia and Herzegovina. The income per capita of this country is €723, and the agricultural income per capita is €713.

This country has 1,851,000 hectares of pasture land. With regard to livestock, it has over 2.5 million head of cattle and close to 1.3 million head of sheep and goats.

Over the past five years meat total production in Serbia and Montenegro has been constant, with slight fluctuations, but always within the same levels. There has been a notable decrease the production of pork, although it is still one of the most notable items. In this country there is barely any production of chicken and sheep and goat meat.

Quantity of meat produced in Serbia and Montenegro (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	194.83	164.85	166	164	161
Sheep and Goat meat	23.73	22.47	20.09	21.9	20.58
Duck, goose or guinea fowl	634.5	564.6	616.7	573.9	538.5
Chicken	68	63.92	67.24	59.16	66.46
Other meats	14.2	15.63	15.19	14.99	13.46
TOTAL	**935.26**	**831.47**	**885.22**	**833.95**	**800**

Source: *Food and Agriculture Organization of the United Nations.*

Although there have been certain fluctuations, the total consumption, and production, of meat in Serbia and Montenegro has remained constant. In this country there is barely any consumption of rabbit or horse meat, while the meat with the highest consumption is pork, followed at a great distance by chicken and beef.

Meat consumption in Serbia and Montenegro (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	37.4	32.17	30.55	31.62	32.3
Pork	114.57	113.11	111.67	109.66	107.3
Horse meat	0.17	0.15	0.15	0.16	0.16
Sheep and Goat meat	5.94	5.70	5.51	5.42	5.51
Turkey meat	3.08	3.15	3.21	3.16	3.03
Chicken	18.59	19.63	20.56	21.38	22.15
Other meats	0.36	0.46	0.52	0.53	0.49
TOTAL	**182.7**	**176.93**	**174.75**	**174.52**	**173.51**

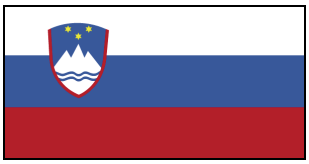
Source: *Food and Agriculture Organization of the United Nations.*

Serbia and Montenegro are clearly importers of meat. The meats that are imported in the greatest quantities are pork and chicken. Even though they are also the largest export items, imports are significantly higher than exports. For the remaining meats, there are virtually no trade deficits or surpluses.

Trade of meat in Serbian and Montenegro 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	2.31	2.84	-0.53
Pork	2.99	15.8	-12.81
Sheep and Goat meat	0	0.04	-0.04
Turkey meat	0	0.82	-0.82
Chicken	3.82	13.02	-9.2
Other meats	0.99	0.42	0.57
TOTAL	**10.11**	**32.94**	**-22.83**

Source: *Food and Agriculture Organization of the United Nations.*



SLOVENIA

POPULATION[04] (1,000): 1,982
AREA: 20,253 km²
INCOME PER CAPITA[02] (€): 9,174
MEAT PRODUCTION (1,000 t): 180
MEAT CONSUMPTION (1,000 t): 117.97

[02]: 2002; [04]: 2004

Slovenia has borders with Italy, Austria, Hungary and Croatia. While the income per capita is €9,174, the agricultural income per capita is almost double that, at €17,424.

With regard to resources, Slovenia has 314,000 ha of pasture land, 473,000 head of cattle and buffalo and 29,000 head of sheep and goats.

In recent years meat production in Slovenia has been irregular, although it did increase between 2000 and 2004. The meats with the highest production are pork followed by beef, and between them they account for over 65 % of the total.

Quantity of meat produced in Slovenia (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	43.3	49.1	42.7	51.8	46.9
Pork	60	66.4	62	63.6	71.3
Horse meat	0.35	0.37	0.3	0.33	0.33
Sheep/goat meat	0.93	1.2	1.2	1.24	1.1
Duck, goose or guinea fowl	4.7	4.7	4.7	4.7	4.6
Turkey meat	8.4	8.4	8.4	8.4	8.4
Chicken	54.2	58.7	53.2	54.4	47
Other meats	0.3	0.15	0.15	0.15	0.15
TOTAL	**172.2**	**189**	**173**	**185**	**180**

Source: *Food and Agriculture Organization of the United Nations.*

Over the last five years meat consumption in Slovenia has decreased progressively. The consumption of beef and pork has practically halved, and the consumption of chicken has also fallen considerably. In spite of this, they are still the most consumed meats in this country, with the three of them accounting for over 86 % of consumption.

Meat consumption in Slovenia (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	61.79	60.95	52.44	66.41	32.6
Pork	105.1	112.4	107	108.1	59.7
Rabbit meat	0	0	0	0	0.01
Horse meat	0.68	0.95	0.79	0.68	0.53
Sheep/goat meat	1.14	1.65	1.66	1.71	1.58
Duck, goose or guinea fowl	8.34	6.98	7.1	6.99	6.61
Turkey meat	11.68	11.57	13.09	12.49	12.6
Chicken	77.43	65.9	60.03	59.26	49.4
Other meats	0.07	0.2	0.11	0.1	0.19
TOTAL	**266.2**	**260.6**	**242.2**	**255.8**	**163**

Source: *Food and Agriculture Organization of the United Nations.*

Over the last year Slovenia has exported a greater quantity than it is has imported, hence its balance for the meat trade is positive. The principal meat exported was chicken, followed by pork. With regard to imports, the largest item was pork at 22,070 tonnes, over 70 % of the total.

Meat trade in Slovenia for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	5.43	3.11	2.32
Pork	11.83	22.07	-10.24
Rabbit meat	0	0.01	-0.01
Horse meat	0	0.04	-0.04
Sheep/goat meat	0	0.02	-0.02
Duck, goose or guinea fowl	0.02	0.2	-0.18
Turkey meat	0.65	1.4	-0.75
Chicken	16.9	4.03	12.87
Other meats	0.22	0.21	0.01
TOTAL	**35.05**	**31.09**	**3.96**

Source: *Food and Agriculture Organization of the United Nations.*

 **SPAIN**	POPULATION[04] (1,000): 41,128
	AREA: 504,782 km^2
	INCOME PER CAPITA[02] (€): 13,233
	MEAT PRODUCTION (1,000 t): 5,530.75
	MEAT CONSUMPTION (1,000 t): 3,552.51

[02]: 2002; [04]: 2004

Spain has borders with Portugal and France. Its income per capita is €13,233, and its agricultural income per capita is €7,360.

With regard to resources, Spain has over 11,000,000 ha of pasture land. The livestock census shows almost 6.5 million head of cattle and over 26 million sheep and goats.

The amount of meat produced in Spain has increased progressively over the last five years, exceeding 5.5 million tonnes in 2004. Of these, 3,175,630 t., over 57 %, corresponded to pork, and the second meat in terms of the quantity produced is chicken, with 1,268,280 tonnes. However, there has been a reduction in the production of horse meat.

Quantity of meat produced in Spain (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	651.09	650.84	678.84	706.37	702.33
Pork	2,904.62	2,989.15	3,070.12	3,189.51	3,175.63
Rabbit meat	103.6	111.51	119.02	111.58	106.61
Horse meat	7.58	8.05	6.8	5.83	5.97
Sheep/goat meat	248.82	251.18	252.14	250.13	244.84
Turkey meat	22.5	22.6	19.67	24.29	20.59
Chicken	966.4	1,008.53	1,191.19	1,187.38	1,268.28
Other meats	6.5	6.7	6.1	6.3	6.5
TOTAL	**4,911.11**	**5,048.56**	**5,343.88**	**5,481.39**	**5,530.75**

Source: *Food and Agriculture Organization of the United Nations.*

Over the last year, and despite the rising trend of recent years, meat consumption in Spain has fallen. Worthy of mention is the fact that pork consumption has fallen by half. The meat whose consumption has increased most is chicken, which together with pork, is the most consumed.

Meat consumption in Spain (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	40.32	40.25	43.05	42.92	31
Pork	174.2	176.1	177.9	180.2	90.1
Rabbit meat	6.68	7.18	7.76	7.22	6.86
Horse meat	0.49	0.53	0.44	0.38	0.38
Sheep/goat meat	16.45	16.12	16.16	16.35	15.9
Duck, goose or guinea fowl	0.25	0.29	0.35	0.39	0.35
Turkey meat	3.05	2.91	2.29	2.65	2.38
Chicken	65.5	68.8	81.27	80.92	88.8
Other meats	0.86	2.13	1.53	1.05	0.9
TOTAL	**307.8**	**314.3**	**330.7**	**332.1**	**237**

Source: *Food and Agriculture Organization of the United Nations.*

Spain mainly exports pork, 524,880 tonnes, accounting for over 68 % of the total for exports. Only in pork and rabbit meat does it have a positive net trade balance. The greatest quantities of meat imported correspond to beef. The total volume of exports was €1,629.7 million, of which more than €1,099 million were for pork. The total volume of imports reached €884 million, and in terms of value, the most important item was beef, followed by pork and chicken.

Meat trade in Spain for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	131.02	200.52	-69.5
Pork	524.88	262.41	262.47
Rabbit meat	4.63	0.44	4.19
Horse meat	0	0.02	-0.02
Sheep/goat meat	20.23	10.2	10.03
Duck, goose or guinea fowl	0.28	5.56	-5.28
Turkey meat	18.34	33.58	-15.24
Chicken	60.63	185.33	-124.7
Other meats	8.15	14.53	-6.38
TOTAL	**768.16**	**712.59**	**55.57**

Source: *Food and Agriculture Organization of the United Nations.*

SYRIA

POPULATION[04] (1,000): 18,223
AREA: 185,180 km^2
INCOME PER CAPITA[02] (€): 610
MEAT PRODUCTION (1,000 t): 391
MEAT CONSUMPTION (1,000 t): 395.15

[02]: 2002; [04]: 2004

Syria has borders with Turkey, Iraq, Jordan, Israel and Lebanon. Its income per capita of €610 has been increasing since 1990. Its agricultural income per capita is €627.

With regard to resources, it has 8 million ha of pasture land. The livestock census shows more than 883,000 head of cattle and buffalo, and 14.5 million sheep and goats.

Over the past five years, meat production has increased in Syria, especially with regard to the production of sheep/goat meat and chicken. Other items have decreased or maintain the same level of production. The meat with the highest production is sheep/goat meat, which accounts over a third of the total.

Quantity of meat produced in Syria (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	47.26	42.42	47.22	47.51	47.52
Rabbit meat	0.52	0.45	0.41	0.45	0.45
Sheep/goat meat	188.8	173.5	188.6	212.1	212.1
Duck, goose or guinea fowl	0.2	0.19	0.19	0.19	0.19
Turkey meat	4.69	4.55	4.62	4.69	4.69
Chicken	106.6	114.2	123.2	123.2	123.3
Other meats	0.31	0.27	0.27	0.32	2.75
TOTAL	**348.4**	**335.6**	**364.5**	**388.5**	**391**

Source: *Food and Agriculture Organization of the United Nations.*

In spite of a slight fall in 2001, the total consumption of meat in this country has increased over the last five years. In the last two years there has been increasing the consumption of pork, which previously was virtually nil. The consumption of beef and turkey, however, has fallen. For all other items, production has either increased or remained constant. The meat with the highest consumption in Syria is sheep/goat meat, which accounts for over half the total, with 32.4 grams per person per day.

Meat consumption in Syria (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	7.82	6.85	7.47	7.32	7.03
Pork	0	0	0	0.01	0.06
Rabbit meat	0.09	0.07	0.07	0.07	0.07
Sheep/goat meat	31.2	28	29.7	32.7	32.4
Duck, goose or guinea fowl	0.03	0.03	0.03	0.03	0.03
Turkey meat	0.78	0.73	0.73	0.72	0.71
Chicken	17.6	18.4	19.4	19.2	18.7
Other meats	0.05	0.04	0.03	0.05	0.4
TOTAL	**57.6**	**54.2**	**57.5**	**60.0**	**59.4**

Source: *Food and Agriculture Organization of the United Nations.*

Syria imports more meat than it exports. Only for the “other meats” item is the net trade positive. The principal imports are chicken and pork, which account for 90 % of the total. The total value of exports in 2004 reached €0.26 million, while imports totalled €1.36 million.

Meat trade in Syria for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	0.05	0.12	-0.07
Pork	0.02	0.82	-0.8
Sheep/goat meat	0	0.02	-0.02
Chicken	0.06	0.9	-0.84
Other meats	0.07	0.01	0.06
TOTAL	**0.2**	**1.87**	**-1.67**

Source: *Food and Agriculture Organization of the United Nations.*

TUNISIA

POPULATION[04] (1,000): 9,937
AREA, 163,310 km^2
INCOME PER CAPITA[02] (€): 1,887
MEAT PRODUCTION (1,000 t): 245
MEAT CONSUMPTION (1,000 t): 231.25

[02]: 2002; [04]: 2004

Tunisia is situated between Algeria and Libya. Its income per capita is €1,887, while its agricultural income per capita is €819.

This country has over 4.5 million ha of pasture land, 760,000 head of cattle, and over eight million head of sheep and goats.

From 2000-2003 the quantity of meat produced in Tunisia increased, and fell in 2004. Production has only increased with regard to chicken, while for the rest of the items it has either fallen or remained constant. The largest item of production is chicken, which with 95,600 tonnes accounts for 39 % of total production, followed by sheep/goat meat, with 61,000 tonnes, which represents 25 % of production, and by beef, with 53,400 tonnes, which accounts for 21.7 % of the total.

Quantity of meat produced in Tunisia (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	59.8	62.4	59.8	62.7	53.4
Pork	0.16	0.16	0.15	0.15	0.15
Horse meat	0.45	0.45	0.45	0.45	0.45
Sheep/goat meat	63.9	66.7	67.8	69.1	61.4
Turkey meat	25.75	26.8	24.5	25	25
Chicken	87	91	93.6	90	95.6
Other meats	8.31	8.31	8.31	8.31	9.31
TOTAL	**245.4**	**256**	**255**	**256**	**245**

Source: *Food and Agriculture Organization of the United Nations.*

Over the last year, meat consumption in Tunisia has fallen. Only the consumption of chicken and “other meats” has risen, while the rest have either fallen or remained constant. The meat with the highest consumption is chicken, which accounts for 42 % of the total, with 26.2 grams per person per day.

Meat consumption in Tunisia (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	18.4	17.8	16.9	17.9	11.2
Horse meat	0.13	0.13	0.13	0.13	0.12
Sheep/goat meat	18.2	18.8	18.9	19	16.8
Duck, goose or guinea fowl	0.01	0.01	0.01	0.01	0.01
Turkey meat	7.25	7.42	6.72	6.78	6.88
Chicken	25.1	25.9	26.4	25.1	26.2
Other meats	2.38	2.36	2.32	2.31	2.46
TOTAL	**71.5**	**72.4**	**71.3**	**71.3**	**63.8**

Source: *Food and Agriculture Organization of the United Nations.*

Tunisia is principally an exporter of beef: with a total of 22,060 tonnes, this meat accounts for 97 % of total exports, which generates a positive balance in its net meat trade. Beef is the country's largest import item, with 9,140 tonnes out of a total of 10,580 tonnes of imported meat. In spite of this, for 2004 the value of imports, €20.16 million, was greater than the value of exports, €7.8 million.

Meat trade in Tunisia for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	22.06	9.14	12.92
Pork	0.13	0.23	-0.1
Sheep/goat meat	0	0.93	-0.93
Duck, goose or guinea fowl	0	0.03	-0.03
Turkey meat	0.11	0.08	0.03
Chicken	0.02	0.17	-0.15
Other meats	0.41	0	0.41
TOTAL	**22.73**	**10.58**	**12.15**

Source: *Food and Agriculture Organization of the United Nations.*

TURKEY

POPULATION[04] (1,000): 72,320
AREA: 780,580 km^2
INCOME PER CAPITA[02] (€): 2,157
MEAT PRODUCTION (1,000 t): 1,583
MEAT CONSUMPTION (1,000 t): 1,579.81

[02]: 2002; [04]: 2004

Turkey is the easternmost country of the Mediterranean Arc, and borders on Greece, Georgia, Armenia, Iran, Iraq and Syria. Its income per capita is €2,157, while its agricultural income per capita is €938.

The country has over 12 million ha of pasture land, more than 10 million head of cattle, and 34 million head of sheep and goats.

Over the last three years total meat production in Turkey has increased progressively. With regard to production, the item that has increased most is chicken, which accounts for 55.4 % of the total, with 876,800 tonnes. Next in quantity produced is beef, which accounts for 23.2 %, with 367,000 tonnes, followed by that of sheep/goat meat, with 318,000 tonnes, accounting for 20 % of the total.

Quantity of meat produced in Turkey (1,000 tonnes)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	358.68	333.9	329.3	292.2	367
Pork	0.27	0.09	0.04	0.28	0.17
Rabbit meat	0.04	0.04	0.04	0.04	0.04
Horse meat	2.01	1.95	1.95	1.74	1.95
Sheep/goat meat	374	351	332.5	312	318
Duck, goose or guinea fowl	5.68	5.05	4.54	4.45	4.41
Turkey meat	11.8	11.6	10.2	10.2	13.6
Chicken	643.44	614.7	696.2	872.4	876.8
Other meats	0.21	0.31	0.37	0.37	0.86
TOTAL	**1,396.1**	**1,319**	**1,375**	**1,494**	**1,583**

Source: *Food and Agriculture Organization of the United Nations.*

Despite the slight fall in 2001 and 2002, total meat consumption in this country has increased over the last five years. The most highly consumed item is chicken, and it can also be seen that pork is starting to be consumed, since in previous years consumption was practically nil. With regard to the remaining items, consumption has fallen.

Meat consumption in Turkey (quantity (g)/person/day)

Product/year	2000	2001	2002	2003	2004
Beef (cattle and buffalo)	14.4	13.2	12.8	11.2	13.4
Pork	0	0	0	0	0.18
Horse meat	0.08	0.08	0.08	0.07	0.07
Sheep/goat meat	15	13.9	13	12	12.1
Duck, goose or guinea fowl	0.23	0.2	0.18	0.17	0.17
Turkey meat	0.53	0.45	0.37	0.36	0.49
Chicken	25.7	23.5	26.4	32.6	33.5
Other meats	0	0	0	0	0.02
TOTAL	**55.9**	**51.2**	**52.7**	**56.3**	**59.9**

Source: *Food and Agriculture Organization of the United Nations.*

Turkey imports more meat than it exports. In the case of chicken, turkey and other meats, the net trade is positive. With regard to exports, the largest item is beef, with 76,480 tonnes, accounting for 59 % of the total, followed by chicken and pork. Imports are principally beef and pork, accounting for 98 % of the total. The total value of exports in 2004 exceeded €35,1 million, while imports totalled €35.3 million.

Meat trade in Turkey for 2004 (1,000 tonnes)

	Quantity of exports	Quantity of imports	Net trade (E-I)
Beef (cattle and buffalo)	76.48	141.19	-64.71
Pork	20.87	135.55	-114.68
Sheep/goat meat	0.01	0.08	-0.07
Turkey meat	0.57	0.02	0.55
Chicken	30.9	0	30.9
Other meats	0.67	0.47	0.2
TOTAL	**129.5**	**277.31**	**-147.81**

Source: *Food and Agriculture Organization of the United Nations.*

3. DESCRIPTION OF THE PRINCIPAL PRODUCTION PROCESSES IN THE MEAT PROCESSING INDUSTRY

Three principal types of activities can be distinguished in the meat processing industry:

- The slaughter of animals in slaughterhouses.
- The cutting and portioning of carcasses in cutting plants.
- The production of meat products in production plants.

Slaughterhouses are establishments in which the first stage of meat processing is carried out, where carcasses or half carcasses are obtained as a finished product. The end products obtained in the slaughterhouse can be classified in the following manner:

- Carcasses, half carcasses (sides) and entrails that are fit for human consumption
- Animal by-products, such as leather, hair, blood, offal and other fractions, which may be used in other related industrial activities (food, pharmaceuticals, tanning, etc.).

The stages prior to slaughter, including certain hygienic lairaging conditions and a suitable feeding regime, are essential for obtaining top quality meat.

Similarly, with regard to the quality of the meat, it should be pointed out that after the slaughter of animals, the musculature undergoes a series of primarily physicochemical and biochemical changes until its consumption as meat. These transformations include an initial phase of rigor mortis, and a subsequent maturation phase of highly variable length. Both phases determine to a great extent the quality of the meat.

The end result of establishment of rigor mortis is the disappearance of ATP, accompanied by a fall in pH, and the appearance of muscular rigidity, as well as a substantial decrease in water retention capacity, due to which the meat exhibits certain characteristics of quality that are not strictly desirable. It is during the maturation phase that a series of phenomena occur (softening of the meat, slight increase in the water retention capacity and the development of the characteristic aroma of raw meat) which will have a positive effect on the meat's sensorial quality. The tenderisation of the meat is brought about by the action of proteolytic enzymes in the muscle (proteases), which give rise to a progressive breakdown of the structure of the myofibrils. The development of the characteristic aromas and taste of meat is a result of the accumulation of nitrogenised products of the breakdown, and the action of proteolytic enzymes that give rise to the formation of free amino acids and small peptides.

In cutting plants, half carcasses are cut up into whole pieces and cuttings, to be marketed as fresh meat or as raw material for processing factories. The transformation of pieces of meat into meat products by means of thermal treatment or conditioning gives rise to a series of end products that are boiled, cured, smoked, salted, minced, etc., according to the market for which they are intended and consumer preferences.

Hygiene must be maintained throughout all the stages of the productive process, since it has a direct bearing on the quality and healthiness of the foods that are produced. For this reason, the cleaning and disinfection of equipment and installations is an auxiliary operation of the utmost importance, which has a great deal of influence on the productive process, and which has specific technology and methodology that has been adapted for the sector.

In Europe, part of the carcass cutting activity is carried out on premises annexed to the slaughterhouse, with processing plants remaining as independent installations on a business and industrial level. There are also frequently large plants that work in all three types of activities, generally in the processing of poultry for human consumption.

In the Arab countries on the southern coast of the Mediterranean Sea and the Middle East, the situation is somewhat different with regard to the meat processing industry for food use. It could be said that the concept of the high-production industrial slaughterhouse with a cutting plant and in certain cases, meat processing plant does not exist as such; there they are usually smaller industries, which are principally just slaughterhouses, with lower production and with more traditional, even manual methods, and which are generally designated for fresh meat. Processed products (cooked or cured) are usually imported from other countries, and these are required to have *kosher* or *halal* certificates.

Similarly, the food quality and hygiene standards are lower than those required in European Union countries.

The following section describes the industrial processes of the sector, structured as follows:

- Slaughterhouses and cutting rooms for livestock:
  - Cattle, sheep and goat
  - Pigs
  - Poultry
- Manufacture of meat products (cooked and cured) from:
  - Beef, sheep/goat meat
  - Pork
  - Poultry

3.1. SLAUGHTERHOUSES AND CUTTING ROOMS

The principal aim of slaughterhouses is to produce hygienic and sensorially acceptable meat through the human handling of animals, with respect to the use of hygienic techniques for the slaughter of animals and the preparation of carcasses, by means of a strict division of “clean” and “dirty” operations. And at the same time, to facilitate the suitable inspection of the meat and the appropriate handling of the resulting waste in order to eliminate all potential danger of meat in a bad state reaching the consumer or contaminating the environment.

This section describes the principal operational stages carried out in slaughterhouses for cattle, sheep, goats, pigs and poultry.

Figure 3.1 shows an example of the layout of a typical sheep, cattle and pig slaughterhouse.

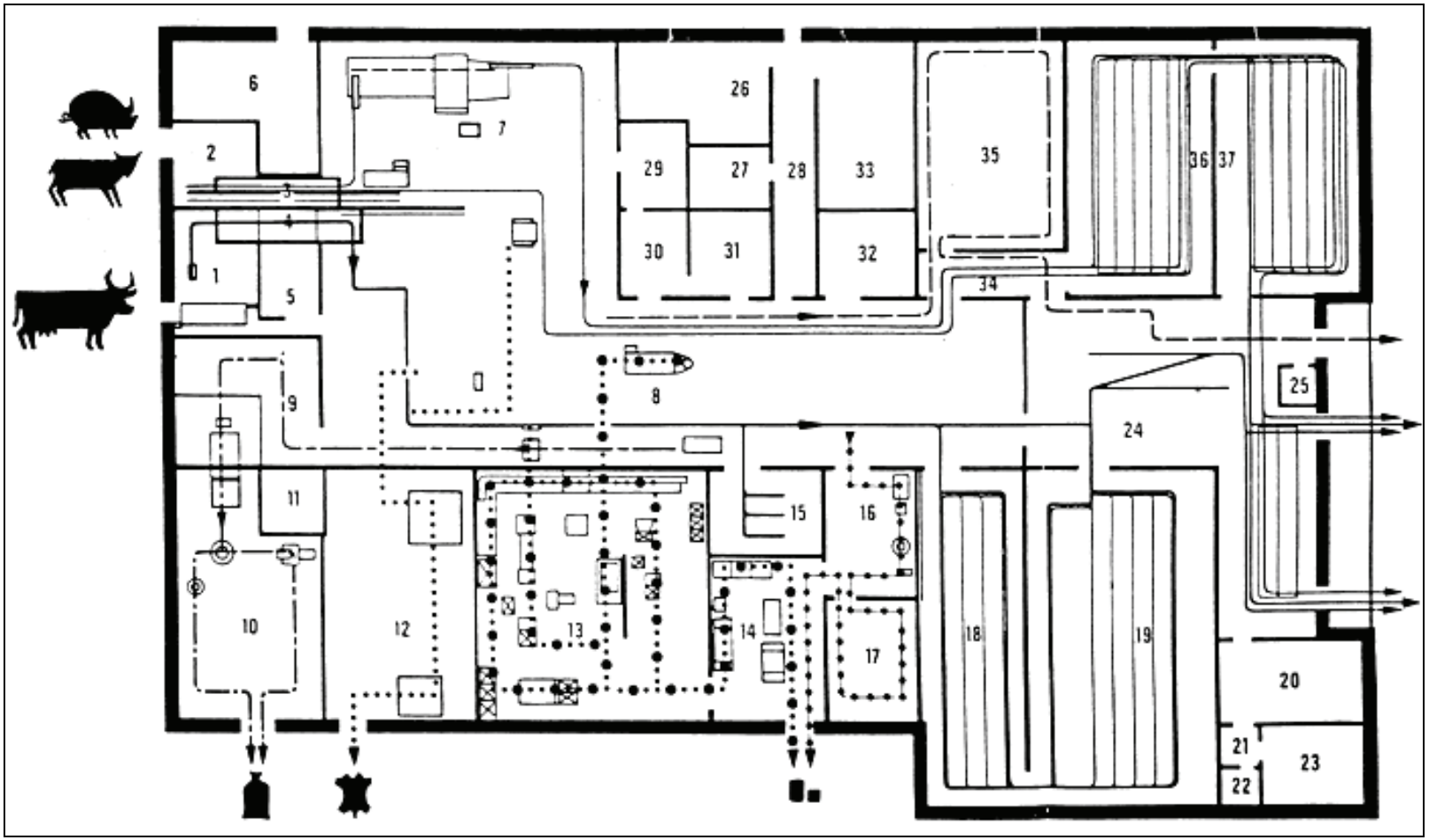
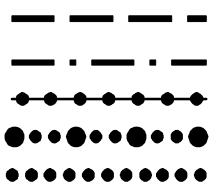


Figure 3.1: Example of the layout of a typical sheep, cattle and pig slaughterhouse.

Flow diagram and plan of a medium capacity slaughterhouse (50-100 head of cattle per day). Source: FAO study Animal Production and Health 97.

Elements of distribution in a typical slaughterhouse,

1. Stunning of cattle 2. Stunning of pigs and sheep 3. Bleeding rail 4. Bleeding rail 5. Blood tank 6. Boiler plant 7. Preparation of pig and sheep meat 8. Preparation of beef 9. Meat extraction and desiccation 10. Room for bone and blood products 11. Salt store 12. Hide and skin warehouse 13. Separation of offal and cleaning of intestines 14. Cold meat warehouse 15. Refrigerated product inspection room 16. Extraction of edible fats 17. Cold chamber for fat 18. Cooling section for sheep 19. Bovine cold storage 20. Office 21. Standing room	22. Toilets 23. Warehouse 24. Loading bay 25. Weighing room 26. Changing Room 27. Toilets 28. Employee entrance 29. Office 30. Vet's office 31. Laboratory 32. Toilets 33. Machine room 34. Passageway 35. Cold chamber for waste 36. Cooling chamber for pigs and sheep 37. Cold storage chamber for pigs and sheep  Waste Condemned Material Fats Guts Hides and skins

3.1.1. Description of the operations of the production process for cattle, sheep and goats

The only differences are in type and size of certain equipment (depending on the morphology of the livestock to be slaughtered), the order of certain stages and the residing times for carcass chilling and refrigeration operations.

Below we describe the production process carried out in slaughterhouses for this type of livestock:

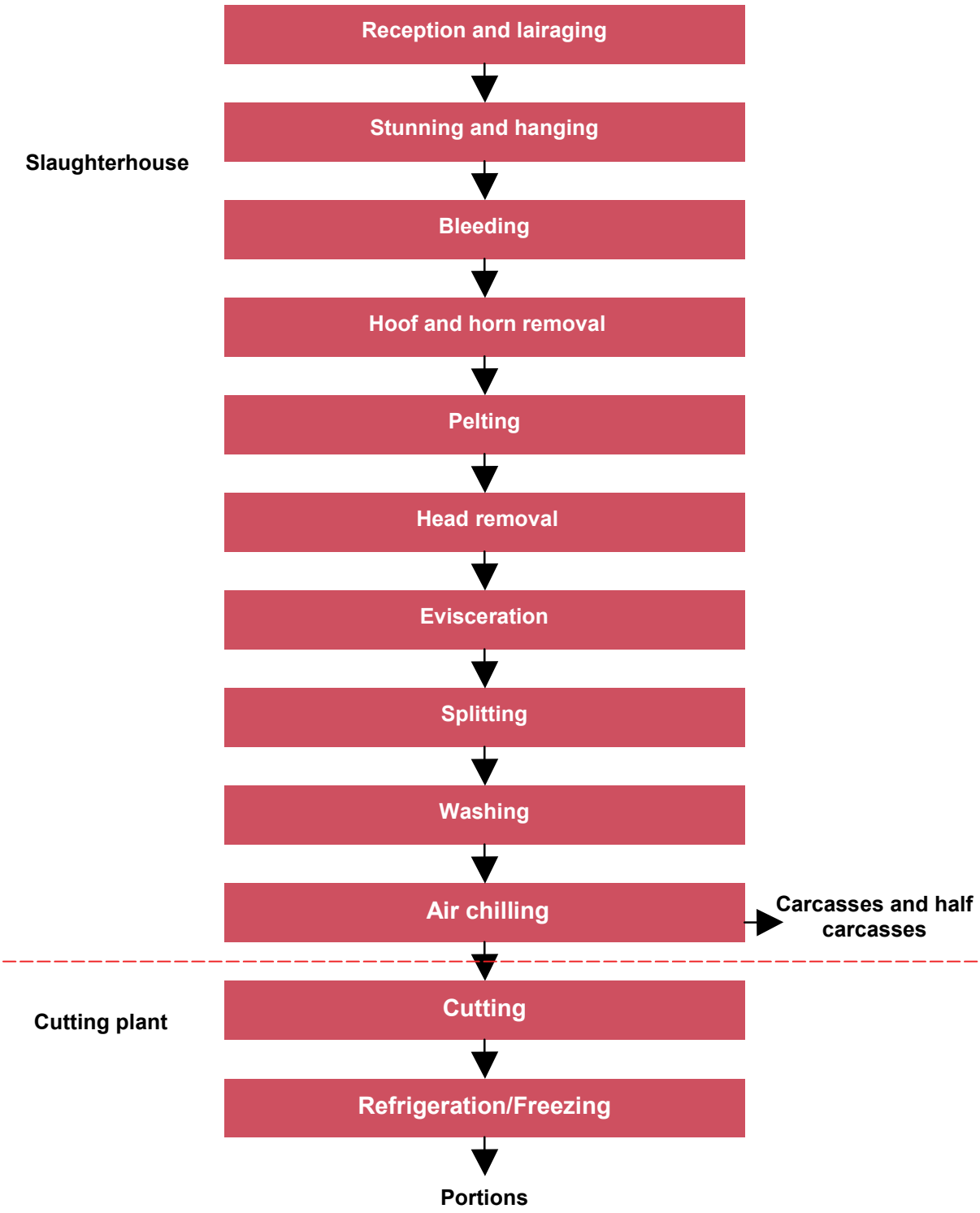


Figure 3.2: Flow chart for the production process for cattle sheep and goats.

3.1.1.1. Reception and lairaging

For the production of high-quality carcasses, besides the suitable rearing and feeding of the animal, adequate transport to the slaughterhouse and suitable lairaging therein is fundamental, and the latter must not exceed 24 hours. In the stables, there must be water points that guarantee the proper hydration of the animals during the time they spend there.

The conditions in which the animals to be slaughtered are housed are very important; with a rest period prior to slaughter a beneficial effect is obtained in the quality of the carcass. Lairaging in cold, damp, low-capacity installations may deplete glycogen reserves, resulting in a slight post-slaughter decrease in pH, and giving rise to DFD (dark, firm and dry) meats.

The sanitary conditions and diet with which the animals arrive at the slaughterhouse may be of importance in certain environmental aspects, such as the quantity of animal manure excreted in the stables, the animal stomach contents or the methane produced and eliminated into the atmosphere. In all cases, the proper management of manure generated in the stables is highly important.

Prior to slaughter, the animals can be given a cold water shower for partial cleaning, and to favour the subsequent bleeding process. In the case of sheep and goats, the washing of animals gives rise to hygiene problems during slaughter if they are not completely dry. Moreover, damp skins deteriorate more rapidly than dry ones, and can give rise to hygiene problems during sanitary dressing.

3.1.1.2. Stunning and hanging

Stunning is carried out to induce a state of unconsciousness and insensibility for a sufficient time to ensure that the animal does not recover before being slaughtered by exsanguination.

At European level, the Animal Welfare Directive (93/119/EEC) establishes that animals must be stunned before slaughter and than killed instantly. The bleeding of the animals must commence as soon as possible: for sheep and goats, the Directive establishes the time limit of 15 seconds between firing and bleeding; for cattle, no specific time is indicated, but it is estimated that at least 30 seconds will be required.

The methods that are currently permitted for stunning are captive bolt pistol, concussion, the use of electrodes and exposure to carbon dioxide. Nevertheless, in practice, exposure to carbon dioxide is not suitable, and is not used to stun ruminants.

Stunning with a captive bolt pistol is widely used for all ruminant species. The captive bolt is used for the majority of cattle, while electric stunning is principally used for sheep and, infrequently, for bovine calves. To shoot the captive bolt through the skull of the animal, explosive cartridges, compressed air or springs are used. Electrodes must be placed in such a way that they cover the brain and allow a current to pass through it. In this case, suitable measures must be taken to ensure good electric contact, by eliminating excess hair or moistening the skin.

In Arab countries and in Israel, where the slaughter of animals for human consumption is determined by religious rites, in principle, it is not permitted to stun the animal before bleeding. This method is applied to Jewish and Muslim rites (*kosher* and *halal* slaughter, respectively).

According to the school of Islamic thought, prior stunning may or may not be permitted (for example, the schools of the Iman Malik and of Abu Hanifa allow prior stunning, providing that the death of the animal takes place at the moment of slaughter). On an industrial scale, this entails certain modifications.

In these cases, all precautions possible must be taken to avoid any arousal, pain or suffering to animals, and it must be carried out by trained, qualified staff. In some European countries, it has been agreed locally, between religious leaders and those responsible for legislation on slaughterhouses, that certain types of stunning are acceptable, even for religious slaughter. This generally entails the use of a non-penetrating stun gun prior to slaughter by bleeding.

After stunning, the animals must be supported in a suitable manner so as not to cause them any unnecessary pain, suffering, excitement, wounds or contusions.

3.1.1.3. Bleeding

Generally, bleeding is induced by making a horizontal incision at the level of the neck to cut the jugular vein. Throat slitting and bleeding after stunning leads to death due to rapid blood loss and the consequent lack of oxygen to the brain. Total exsanguination takes place in all species in approximately 2 minutes.

The hygienic quality with which the blood has been collected will determine its later use. In European Union countries the most habitual practice for this type of livestock is to collect the blood for its later use as a by-product in the manufacture of blood meal. In other European Countries with less well developed meat by-product industries, and in the majority of Arab countries, the blood is poured directly into the drains of the slaughter rooms.

Vertical bleeding is the classic method, permitting the blood to be collected while the animal moves through the bleeding area. There are serious risks of the blood being contaminated with falling faeces, urine, dirt or stomach contents.

With **horizontal bleeding**, the animal (generally pigs) is placed horizontally, and perpendicular to the conveyer belt, is such a manner that the area where the cut has been made (bleeding) is separated from the rest of the animal, and blood is collected more hygienically than the previous case.

For cattle, sheep and goats, vertical bleeding is the most common method.

Ritual slaughter

As mentioned previously, in Muslim countries and in Israel, the slaughter of cattle, sheep and goats is determined by the Muslim rite (halal slaughter) and the Jewish rite (kosher slaughter), in which stunning the animal prior to cutting the throat and exsanguination is not permitted.

In the Jewish ritual, using a sharp knife with a blade some 46 cm long and 3.5 cm wide, the Rabbi makes a rapid lateral incision to cut both jugular veins and both carotid arteries in one single movement, without making any tears or rips. The head is then lifted, while the blood spurts forward. In the case of cattle, the animal's throat is slit horizontally, cutting the trachea and oesophagus.

The Muslim rite consists of cutting the throat, the trachea and the blood vessels simultaneously with a sharp knife, provoking death, but without severing the spinal column. The blood has to flow out before the head is severed.

In both cases the blood must be completely drained from the animal, as the meat that is processed and consumed must carry no trace of blood.

Inevitably, these practices entail the existence of certain differences with respect to the industrial slaughter carried out in European countries or those that are not influenced by these rites, such as the use of specific equipment for the immobilisation of the animal to support it in the position required for the rite in question, principally the position of the head and the posture of the animal (ritual gyratory box), exsanguination time, which is usually longer, or the fact that the animals are hung after bleeding for their subsequent processing.

3.1.1.4. Hoof and horn removal

Once the bleeding of animals has taken place, in the case of cattle, the legs and horns are cut off prior to pelting, or in the case of sheep, the head and legs severed. The extremities may be cut off with a knife or with shears; horns are usually cut off with shears.

3.1.1.5. Pelting

For cattle, pelting may be carried out manually (using knives, and on a platform situated at the level of the operators) or with mechanical pelters by means of traction pelting. In this procedure one end of the skin is attached to a roller, which revolves and detaches the skin, ripping the subcutaneous connective tissue and rolling it onto a drum.

In both cases, pelting is started at the hind end of the animal, at the part where the legs were cut off. As the animal is suspended, with mechanical pelting the skin is folded downwards, and does not come into contact with the meat, thus avoiding microbiological contamination.

In the case of sheep, once the corresponding incisions have been made, pelting is carried out manually with knives. The skins are taken away from the slaughter line to be conditioned, and subsequently recovered.

In the processing of cattle, subsequent to pelting the head is severed, and accompanies the carcass for subsequent veterinary inspection. In the case of sheep, the head may be removed along with the legs prior to pelting.

3.1.1.6. Evisceration

From a hygienic perspective this is a critical operation, which consists of the extraction from the abdominal cavity of the thoracic viscera, fore-stomach, stomach, intestine, spleen and liver. During this stage all possible contamination of the carcass, due to rupture of the stomach or intestines must be avoided. It must be carried out as quickly as possible after the death of the animal (within a maximum time of 45 minutes).

This operation may be carried out manually with knives or a saw, or automatically with a pneumatic pistol. When carried out the oesophagus is usually tied, thus the digestive tract is totally sealed.

In the case of cattle, it is essential remove the so-called high risk, or SRM material (such as, the spinal column), as established in the Regulations (EC) 1774/2002, according to which, this material must be eliminated in authorised installations.

The viscera that are intended for human consumption are separated and placed in clean numbered receptacles or containers, which are correlated with the carcass they came from and accompany it until the post-mortem inspection has been concluded.

3.1.1.7. Splitting

Once the animals have been eviscerated, the carcass is cut longitudinally into two parts; this operation is carried out either manually, or more habitually, with a circular saw.

3.1.1.8. Washing

Once the carcasses or half carcasses have been obtained, they are then washed with water to eliminate any remains of blood, fat and bone splinters from the cutting of the carcass, thus reducing the level of micro-organisms that may contaminate its surface. This is a somewhat undefined process. Cold potable water is usually used, without the volume or duration of the shower being determined. Nevertheless, it is advisable to use low volumes of high-pressure water.

Then the corresponding post-mortem veterinary inspection is carried out, in which the carcasses are classified as fit or unfit for consumption.

3.1.1.9. Air chilling of carcasses

Chilling consists of reducing the temperature of the carcass as rapidly as possible, an operation which is normally carried out in two phases. In the first phase, the carcasses are introduced into low-temperature refrigeration chambers (-3 °C and 0 °C) with the aim of rapidly reducing the body heat of the carcasses, which at that moment is around 40 °C. After 12 hours, the carcasses are stored in chambers at a temperature between 0 and 4 °C (second stage), where they remain until they are subsequently sold.

EEC Directive 91/497 requires fresh meat to be immediately refrigerated after post-mortem inspection, and maintained at a constant internal temperature of no more than 7 °C for carcasses.

At this point, the refrigerated carcasses or half carcasses can be frozen for a variable amount of time, sent directly to shipping, and to the consumer market, or sent to the cutting plants. It must be ensured that the freezing process takes place post rigor mortis, otherwise intracellular crystals will be formed, which can give rise to “freezing rigor”, since during this phase the muscular fibre contracts strongly, resulting in hard, dry meat.

3.1.1.10. Cutting

In cutting plants, the half carcasses coming from the slaughterhouse are boned and cut into small parts, according to the needs of the clients or the meat product to be manufactured subsequently. Cutting takes place in a refrigerated room where a constant temperature of 12 °C is maintained.

3.1.1.11. Refrigeration/Freezing of pieces

As happens with the carcasses, depending on whether they are shipped directly to the market or in the medium-term, the pieces can be refrigerated or frozen.

In other cases, both refrigerated and frozen, the pieces can be sent to meat processing industries.

3.1.2. Description of the operations of the production process for pigs

With regard to the sequence of operations that occur for the slaughter and preparation of carcasses and half carcasses, the industrial processing of pigs is similar to the process described above. The main difference with cattle, sheep and goats is that the carcass is processed along with the animal skin, which is not removed after bleeding; due to which it is necessary to carry out a conditioning treatment to the skin while on the animal, in order to remove dirt and hair.

Below we describe the productive process carried out in slaughterhouses for this type of livestock:

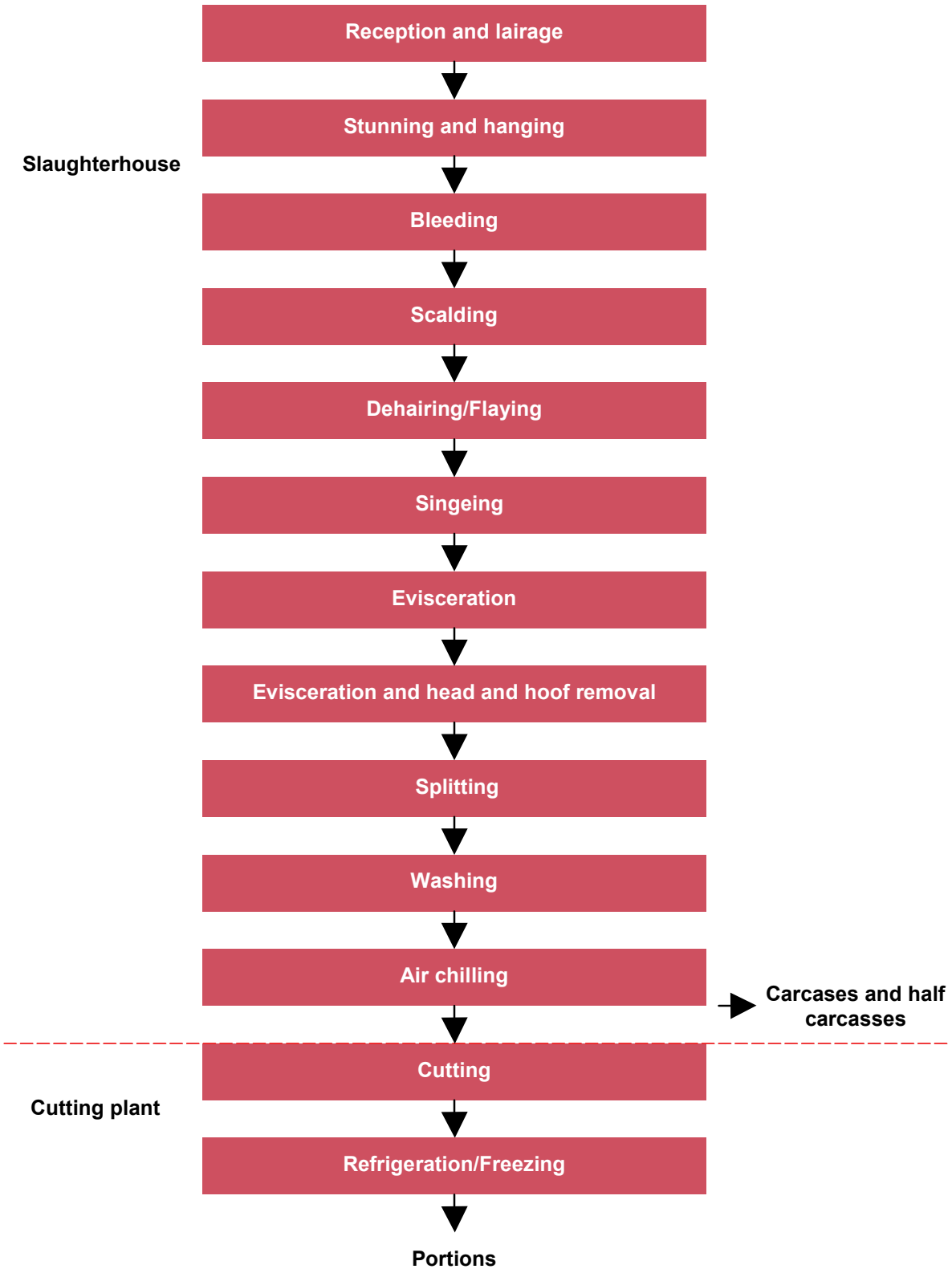


Figure 3.3: Flow diagram of operations of the production process for pigs.

3.1.2.1. Reception and lairaging

In the same way as with cattle, sheep and goats, suitable lairaging of the animals prior to slaughter will have a positive influence on the quality of the meat. All too frequently, ante mortem stress on pigs negatively affects the quality of the meat (DFD and PSE meats).

Unlike other types of livestock, pigs are usually washed to remove any dirt present on the skin.

3.1.2.2. Stunning and hanging

The animals are taken from the stables to the stunning area through passageways that impede the free movement of the animal. Prior to slaughter, the animals are stunned and anaesthetised to leave them in an immediate state of unconsciousness. In the case of pigs, stunning can be carried out with an electric charge by means of electrodes on the animal's head using high-voltage systems (300 to 500 V for 2-3 seconds) or by immersion in CO_2 chambers.

The equipment used for carbon dioxide stunning consists of one or more containers which are lowered into a chamber with a mixture of 70 to 80 % of carbon dioxide and air. The animals are exposed to this atmosphere for approximately one minute, and are then placed on a table for hanging. The subsequent bleeding has to take place during the 20 to 60 seconds after hanging, before the animal regains consciousness.

One of the advantages of carbon dioxide stunning as opposed to electric stunning is that it is more conducive to the bleeding of animals. Nevertheless, the acceptability of this method from a humanitarian point of view has been questioned: for certain types of pig it may be satisfactory, but for others it may be stressing

Argon gas is currently being evaluated for the purposes of stunning. It is supposed that argon has certain advantages over CO_2, but the costs may be somewhat higher.

3.1.2.3. Bleeding

Generally, bleeding is induced by making a horizontal incision at the level of the neck to cut the jugular vein. The tools that are employed (one knife per animal) are put in sterilising devices after each use.

In the same way as for cattle, part of the blood can be collected for subsequent use in by-products, hence the hygienic quality with which it is collected will, to a great extent, determine the possibilities for later use.

In this sense, in addition to the previously described vertical and horizontal bleeding methods, suction knives are used to pump the blood directly from the animal to a thermally controlled collection tank, making it possible to collect the blood without any risk of intermediate contamination. This means that this blood can later be used for human consumption.

3.1.2.4. Scalding

The aim of this operation is to make it easier to remove hair from the skin. In order to do so, the hanging animals pass through scalding tanks with hot water at a temperature of between 60 and 62 °C for between five and six minutes. The animal's contact with water may be through immersion or via showers, where the water is sprayed onto the animal through diffusing nozzles along the whole length of the tunnel. In the case of immersion, water that is lost or dragged out by the animals has to be replaced. In the second case, the re-use of water is possible to some extent.

A variant of these systems is steam scalding, whereby the carcasses also enter a tunnel where diffusing nozzles emit steam. A cold water system reduces the temperature to 63 – 64 °C, bringing about the condensation of the steam in the form of drops of finely atomised hot water which fall onto the surface of the pig's skin and cause the scalding effect.

3.1.2.5. Dehairing/Flaying

Once the animal has been scalded, it is fed into the depilating machine, which has a number of scrapers or rotating cylinders with rubber fingers, which, when turning, remove the majority of hair by friction.

3.1.2.6. Singeing

After dehairing, the animal is subjected to a process of singeing, generally automatically in tunnels, with the aim, on the one hand, of eliminating those parts of the skin that have not been removed, and on the other, to destroy any bacteria present on the skin in order to improve the subsequent conservation of the carcass.

This normally takes place in tunnels fitted with propane burners, which operate intermittently as the animals go through, enveloping the entire carcass for a few seconds.

3.1.2.7. Washing

The cleaning process is concluded by washing the carcass to remove any residue that may have remained from the previous stages. This is usually done with water at a certain pressure.

3.1.2.8. Evisceration and removal of head and hooves

Evisceration must take place as soon as possible after the death of the animal. It is a vital operation from the perspective of hygiene. Tools, the handler's hands, cuts and ruptures of the intestines, intestinal tract, etc. may be the causes and origin of microbial contamination in the meat. During this stage, the oesophagus and the rectum should be tied to avoid any contamination from the intestinal tract.

The red and white entrails are then removed, and placed on trays, which will accompany the carcass for the subsequent veterinary inspection.

The white viscera are sent to the offal zone, where they are washed and treated for subsequent recovery - generally in the manufacture of sutures or meat products.

3.1.2.9. Splitting

Once the animals have been eviscerated, they are cut into two half carcasses, by means of a longitudinal cut along a spinal column with a circular saw.

3.1.2.10. Washing

Once the half carcasses have been attained, they are cleaned with high-pressure cold water to remove any remains of bone, blood, etc, and to reduce surface bacterial contamination as far as possible.

3.1.2.11. Air chilling

Chilling consists of reducing the temperature of the carcass as rapidly as possible - an operation which is normally carried out in two phases. In the first phase, the carcasses are introduced into low-temperature refrigeration chambers (-3 °C and 0 °C), with the aim of rapidly reducing the body heat of the carcasses, which at that moment is around 40 °C. After 12 hours, the carcasses are stored in chambers with a temperature between 0 and 4 °C (second stage), where they remain until they are sold.

At this point, the refrigerated carcasses or half carcasses can be frozen for a variable amount of time, sent directly to shipping, and to the consumer market, or sent to cutting plants.

3.1.2.12. Cutting

In the cutting plant, the half carcasses coming from the slaughterhouse are boned and cut into small pieces, according to the needs of the clients of the meat to be manufactured subsequently. Cutting takes place in a refrigerated room were a constant temperature of 12 °C is maintained.

3.1.2.13. Refrigeration/Freezing of pieces

As happened with the carcasses, depending on whether they are shipped to the market directly or in the medium-term, the pieces can be refrigerated or frozen. In other cases, either refrigerated or frozen, the pieces can be sent to meat processing plants.

3.1.3. Description of the operations of the production process for poultry

In the same way as for the previous cases, the transport and collection of poultry will have a bearing on the quality of the meat obtained, due to which these operations must be carried out in the most favourable manner possible.

Currently industrial poultry slaughterhouses in European countries are highly mechanised, and they usually have built-on cutting plants, and even processing (cold meats, hamburgers, pâté, cooked, etc.) and precooking plants.

In Maghreb and Middle Eastern countries, this concept of multipurpose industrial installations is not very well-developed, and installations for processing poultry meat are of lower production and make less use of technology.

In Muslim countries and in Israel, the non-consumption of pork products means that processed poultry (chicken and turkey) products are greatly appreciated.

Below is a flow chart of the operations carried out in a poultry slaughterhouse and cutting plant.

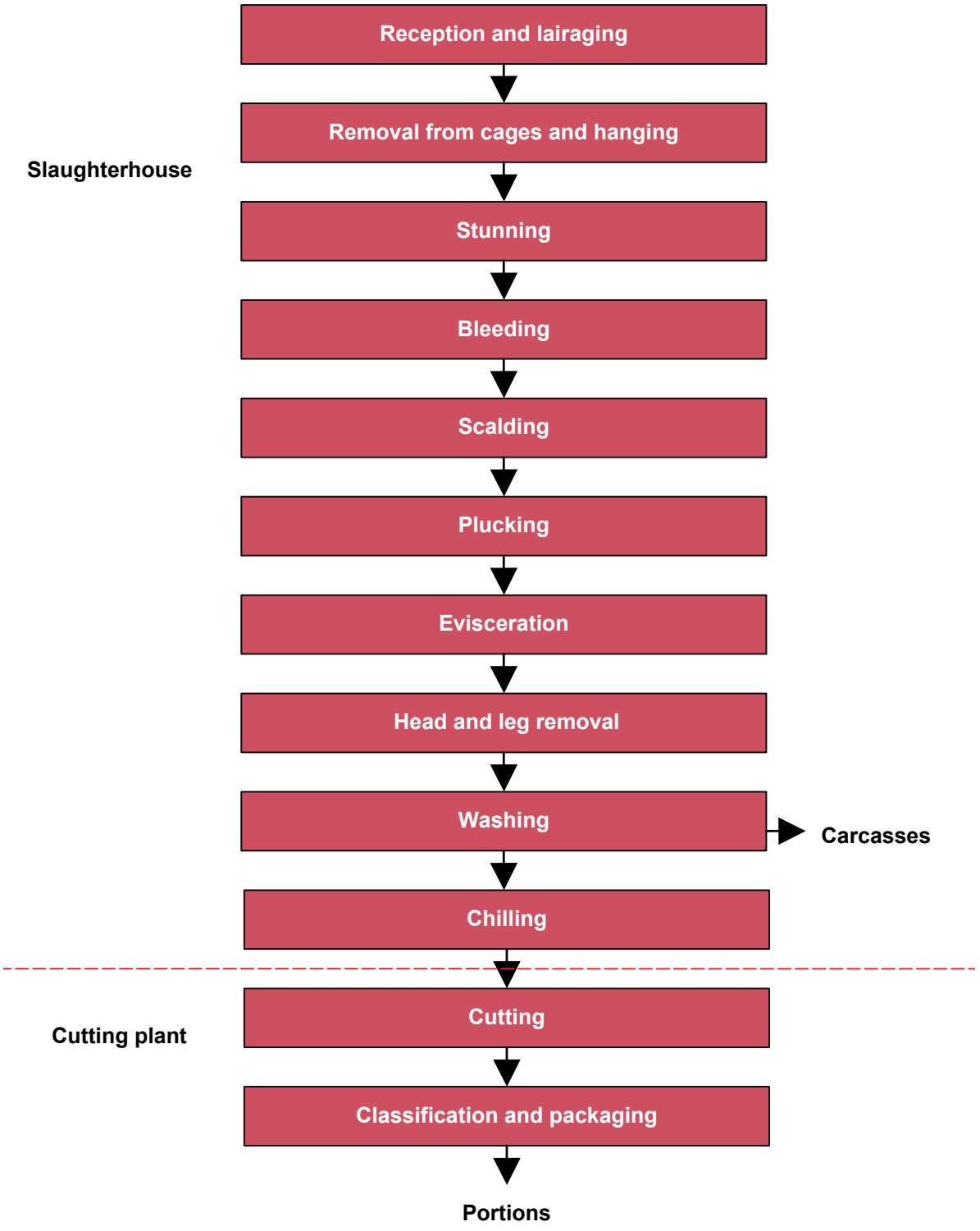


Figure 3.4: Flow diagram of operations of the productive process for poultry.

3.1.3.1. Reception and lairaging

The birds arrive at the slaughterhouse in cages, where they await unloading from the trucks at the moment when they are to be slaughtered. The lairage area must be peaceful, and well ventilated. The poultry must be slaughtered within 24 hours of their arrival at the slaughterhouse.

Special effort must be made to coordinate the moment of catching animals with the demands of the slaughterhouse's production, in order to limit the period during which birds are kept in containers before transport.

When the birds have been captured, measures must be taken to avoid panic, injury or asphyxia, which may include, for example, reducing the intensity of illumination or using blue lighting.

3.1.3.2. Removal from cages and hanging

The operation of removal from cages and hanging on the slaughter line is carried out in a separate room apart from the waiting zone and the slaughter bay. They are hung upside down by the feet on individual hooks hanging from the slaughter line. From the perspective of meat quality, this operation is also vital, due the ease with which the birds can suffer from multiple injuries.

The cages are removed and taken to a cleaning and disinfecting area; this is usually done automatically with machines.

3.1.3.3. Stunning

The aim of stunning is to render the birds insensitive to pain, making it possible to kill the birds humanely and thus produce better quality carcasses. Electrical stunning is the most common method, and this consists of electrifying the hooks and submerging the heads of the birds in a tank of ionised water, with which the bird receives a light electric shock, which stuns it when the electric circuit is completed.

In recent years systems have been developed for stunning by asphyxia in a modified atmosphere, resulting in birds reaching the bleeding stage totally unconscious, which is beneficial for the final meat. In this case, the birds are stunned in the cages themselves, and once they are unconscious, they are hung on the slaughter line to for their throats to be slit.

In Arab countries and in Israel, where the slaughter of animals for human consumption is determined by religious rites, in principle, it is not permitted to stun the animal before bleeding, as it must be alive at the time of sacrifice. This method is applied to Jewish and Muslim rites (*kosher* and *halal* slaughter, respectively).

In the case of poultry, electrical stunning in industrial slaughterhouses simply renders them slightly unconscious, due to which the majority of Muslim communities habitually accept the denomination of *halal* for this poultry meat.

In Maghreb and Middle Eastern countries, which the processes are more traditional and manual, it is likely that no type of stunning is applied to birds prior to slaughter.

3.1.3.4. Bleeding

Slaughter has to be carried out soon after stunning. It is advisable to wait 30 seconds after electrical stunning. The throat can be slit either manually or automatically. This is done by making an external incision in the side of the neck, so that the animal's jugular vein and carotid artery are cut, or by introducing a implement into the trachea to cut the jugular vein. In this way the carcass has a better appearance, with no wounds or bruising.

In the Maghreb countries a manual cut is preferred. In European countries, for the meat to be considered *halal* in the case of automatic slitting, a double blade or transversal cut can be employed to ensure the total cutting of the veins, arteries and trachea.

With respect to *kosher* meat, the Torah explicitly prohibits the consumption of blood; hence the birds must be totally bled.

Bleeding usually takes place in tunnels at a controlled speed; it is recommended that the bleeding time should be over 2 minutes, to ensure that the animals do not enter the scalder alive, and to thus recover a greater quantity of blood.

It is unlikely that in non-EU countries the blood be collected, either for human consumption, or for subsequent recovery as a by-product, due to which it will most likely end up in the final effluent.

3.1.3.5. Scalding

This operation is carried out to loosen the feathers, and thus to make plucking easier. It is usually carried out by submerging the birds in a bath of hot water at 49-52 °C (depending on the type of scalder) for 2-3 minutes.

Stirring the water in the scalder (pumping, turbines or air injection) facilitates the penetration of the hot water between the feathers allowing it to reach the skin.

3.1.3.6. Plucking

Feathers are removed by using machines fitted with a series of disks, drums or other devices with rubber fingers, which, when the birds pass in the opposite direction to the rotation, pluck the feathers from the skin follicles. The operation is concluded by subjecting the bird to the action of straps, which remove any feathers that may have been missed. This operation is accompanied by showering with water, which carries the feathers to a lower channel, whence they are transported to a collection area. There is normally a manual revision to prevent any feathers from reaching the later stages of the process.

From the point of view of hygiene this operation is vital, since it is carried out in a warm humid environment which can favour microbial growth. This is compounded by the possibility of the rubber fingers propagating contamination from one animal to another. Hence, an abundant shower is required after each operation is complete.

3.1.3.7. Evisceration

The evisceration operations are carried out in a different section from scalding and plucking, where the temperature is regulated. In this stage the entire intestine is removed, taking special care not to contaminate the interior of the carcass with faecal material or bile. This can be carried out manually, or with a vent gun, which sucks out the contents of the bird's cloaca and causes it to collapse.

Evisceration is carried out in the following phases: hanging on the preparation belt, cutting the skin of neck, cutting of the cloaca, abdominal opening, extraction of the viscera and cutting of the neck.

The extraction of the viscera from the carcass is carried out using automatic machines which extract the crop, gizzard, intestines, liver, spleen, heart and lungs in one go. All the instruments used are cleaned and disinfected after each use. These viscera will have different destinations, depending on whether they are edible giblets (heart, gizzard and liver) or inedible ones. The post-mortem inspection is carried out during this operation. The edible giblets are classified, chilled and then packed. The remaining giblets, waste and feathers are removed as soon as possible to avoid contamination.

3.1.3.8. Head and leg removal

In high-production industrial slaughterhouses the head is severed with automatic machines fitted with two guide bars between which the heads pass. These bars pull the head and sever it along with the oesophagus and the trachea. Waste from this operation can be vacuum removed.

Legs are cut off automatically at the tarsus. Care must be taken that the cut should not leave any sharp, irregular ends that could damage the packaging in which the carcass is placed.

3.1.3.9. Washing

The washing of carcasses after evisceration is obligatory. The aim is to clean carcasses of any remains of viscera, bone splinters and blood, as well as to eliminate, in part, any microbial surface contamination. This is usually done with water at a certain pressure.

3.1.3.10. Chilling

After washing, carcasses are either taken off the line and placed in boxes, which are then placed in refrigeration chambers, or they are transported directly from the lines themselves to the chambers.

The aim of rapid chilling is to slow down or prevent the growth of micro-organisms present in the carcass, as well as to delay enzymatic maturation. When leaving the standing chamber the temperature of the carcass must be 4 °C or lower.

Chicken and turkey carcasses are classified according to their appearance and weight. They are usually packaged in plastic boxes or plastic-coated trays. Depending on their destination, they are kept in refrigeration or freezing chambers. At this point the carcasses can either be sent for shipment and to the consumer market, or sent to the cutting or meat processing plants.

3.1.3.11. Cutting

In cutting plants, the carcasses are cut up into smaller pieces. The extent of division depends principally on the type of meat and its destination.

In the case of poultry, cutting up is carried out on work benches, obtaining half carcasses, quarters, wings, ribs, breasts, drumsticks and thighs.

3.1.3.12. Classification and packaging

The different pieces of chicken and turkey are classified according to their appearance and weight, and are usually packaged in plastic boxes or plastic-coated trays. Depending on their destination, they are kept in refrigeration or freezing chambers.

3.2. MEAT PROCESSING

Regardless of the type of meat, there are two types of processed meat products: cooked and cured. In both cases, the processing, cooking or curing can be carried out on whole pieces (hams, shoulders, legs, breasts, etc.) or minced meat (also called sausages, such as sausages, *mortadellas*, *fuets*, *chorizos*, etc.).

We now go to indicate the characteristic operations in the manufacture of the types of products, and which of them are obtained from what type of meat (beef, mutton, pork, chicken and turkey).

3.2.1. Cooked processed products

There are two types of cooked processed products: those made from whole pieces, and minced and restructured. Below is a flow diagram for these processes.

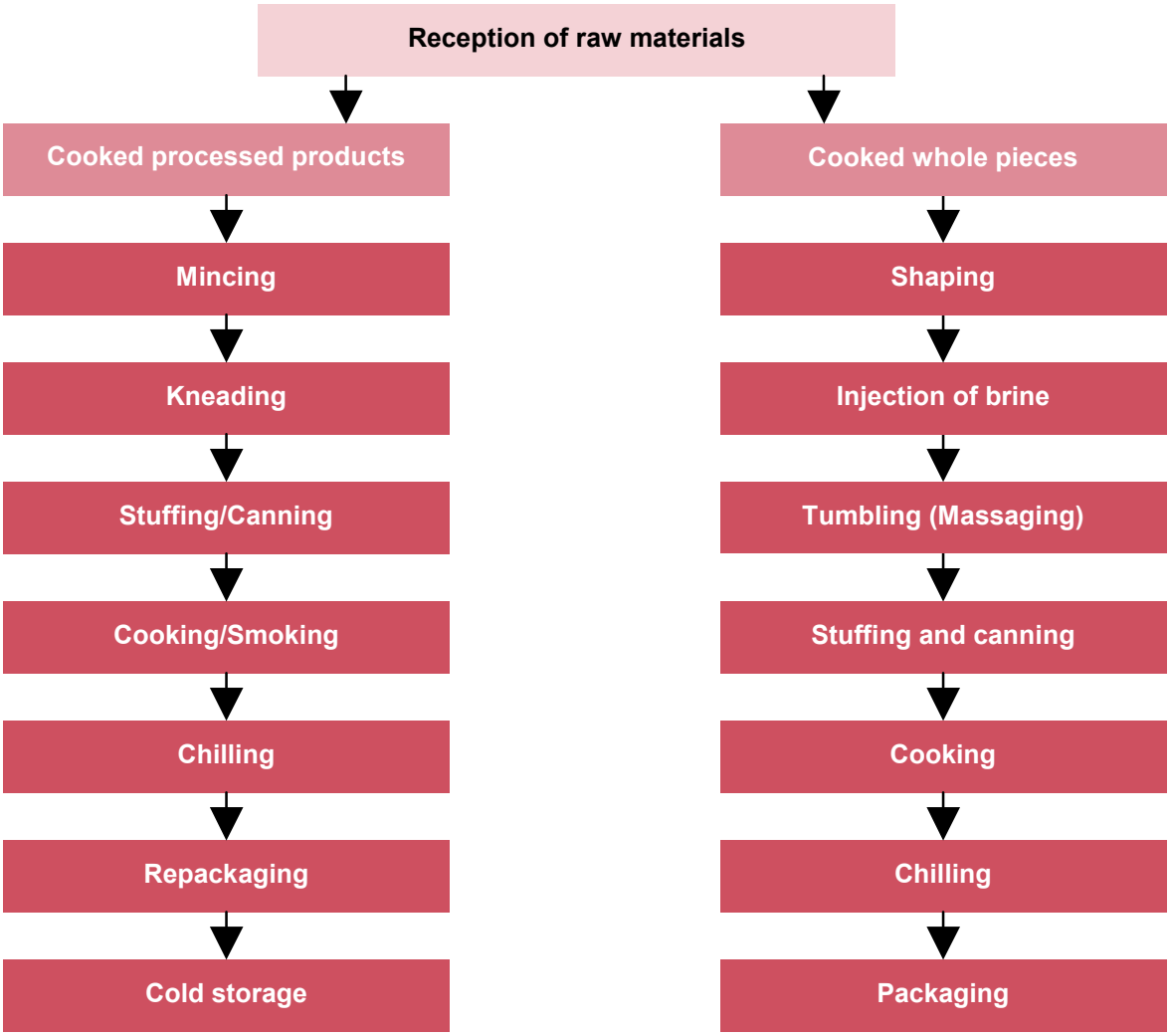


Figure 3.5: Flow diagram of the production process for cooked processed meats.

3.2.1.1. Cooked processed meat from whole pieces

Cooked products from whole pieces are usually pork products, and ham and shoulder are the parts that are habitually used. Once suitable pieces have been selected, they are shaped or cut to be then placed in moulds.

As these are pork products, they are principally manufactured in European or North Mediterranean countries.

No cooked products from whole pieces of beef, mutton/lamb or poultry have been identified in any of the countries in this study.

Injection of brine

Brine is introduced into the pieces of meat, using a multi-needled injector. The injection must be carried out progressively in order to avoid breakage of muscle fibres and the formation of cavities. Both the velocity of the conveyor belt carrying the pieces and the injection are regulated on the basis of the quantity of brine that needs to be injected.

Tumbling (Massaging)

In order to distribute the brine throughout the whole piece of meat it is subjected to continuous massaging with periods of rest. Furthermore, this operation softens up the piece, making it juicier and improving moisture binding in the piece. This treatment lasts between 8-24 hours and is carried out in stainless steel tumbling drums. The equipment has a refrigeration system to maintain the temperature of the meat below 8 °C.

Stuffing/Canning

After massaging, the pieces are packaged or tinned to be subjected to a thermal treatment. This packaging must be made with a vacuum to avoid cavities and bubbles within the final product. The pieces are normally placed in multi-laminar plastic bags.

Cooking/Smoking

This operation is carried out by immersing the product in hot water, in steam ovens, convection ovens, etc. Autoclaves are used for canned food. In all cases, the temperature that has to be reached at the centre of the piece is 65 °C. This process is particularly delicate, as the product to be obtained has to strike a balance between conservation capacity, texture and good organoleptic characteristics. In some cases, products are smoked after cooking.

Chilling

This operation is usually carried out with cold water baths or showers, or in air blast refrigeration chambers. Once chilled, the pieces are removed from the moulds to be stored or re-packaged for cold storage.

Packaging

The cooked products are vacuum-packed in plastic and placed in cold storage avoiding exposure to light, since oxygen and light have negative effects on the colour and conservation time of boiled ham.

3.2.1.2. Cooked minced or restructured products

Cooked minced or restructured products are usually made from beef or chicken or turkey, and generically the most well-known are sausages, chopped meat, mortadella and cold meats (hams and breasts). In Muslim countries, these types of products are typically made from chicken or turkey; in European countries, pork is also used.

Mincing

This is the first operation for making minced meat, where the muscular fibres are destroyed, and the insoluble proteins are dissolved by the action of water and the sodium chloride in the medium. These proteins fix the water and fat that are present, forming an emulsion. Technically, this operation is vital if suitable texture and consistency for the minced meat are to be obtained. From a hygienic perspective, it is a vital step due to the fact that it increases contact surface or for exposure to micro-organisms.

The machinery used includes mincers, colloid mills, cutters, etc, or a combination thereof, and the temperature of the paste must be controlled throughout the process to obtain the desired binding (10-14 °C).

Kneading

The minced meat is mixed with different additives, fats, spices and other ingredients. It is important that this be carried out in the absence of air to avoid undesired oxidation; the use of vacuum mincing and kneading equipment is becoming widespread. Kneading can also be carried out between successive mincing stages.

Stuffing/Canning

During this stage the meat paste is stuffed into natural intestines or flexible casings that are fit for human consumption. In the case of natural casings being used, these must have been subjected to a desalination process beforehand. The type of stuffing equipment used includes piston, compressed air, rotor blades, endless screw, etc.

Cooking/Smoking

The cooking process can be carried out by immersing the product in hot water (cauldrons) or in steam chambers (ovens). In the latter, the meat proteins coagulate due to the thermal action of the water or the hot humid air at 80 °C, due to which a bactericidal effect is obtained thanks to the temperature. In the case of canned meats, the canned paste is heated in autoclaves to over 100 °C, frequently between 115 and 123 °C, for the time required to achieve sterilisation.

Certain minced meats are subjected to a process of smoking to endow the finished product with the flavour of burned wood. This process is carried out in smoking or drying chambers, where both temperature and humidity are controlled.

Chilling

Once the thermal treatment has been carried out, the minced meat is chilled in of cold water baths or showers, or in air blast refrigeration chambers.

Packaging

Cooked products are vacuum-packed in plastic and stored in refrigeration chambers. If, due to technical requirements or commercial preference (adding of gelatine or coating with spices, etc.) the product is to be repackaged, the initial packaging is removed, and it is stored in the most hygienic conditions possible until repackaging is carried out. In these cases, a microbiological stabilisation treatment is usually required (thermal treatment, high pressures, chemical antibacterial agents, etc.) to counteract any possible bacterial contamination that may have taken place during the handling of products.

3.2.2. Cured processed products

There are two types of cured processed products, either from whole pieces or minced and restructured. Below is a flow diagram for these processes,

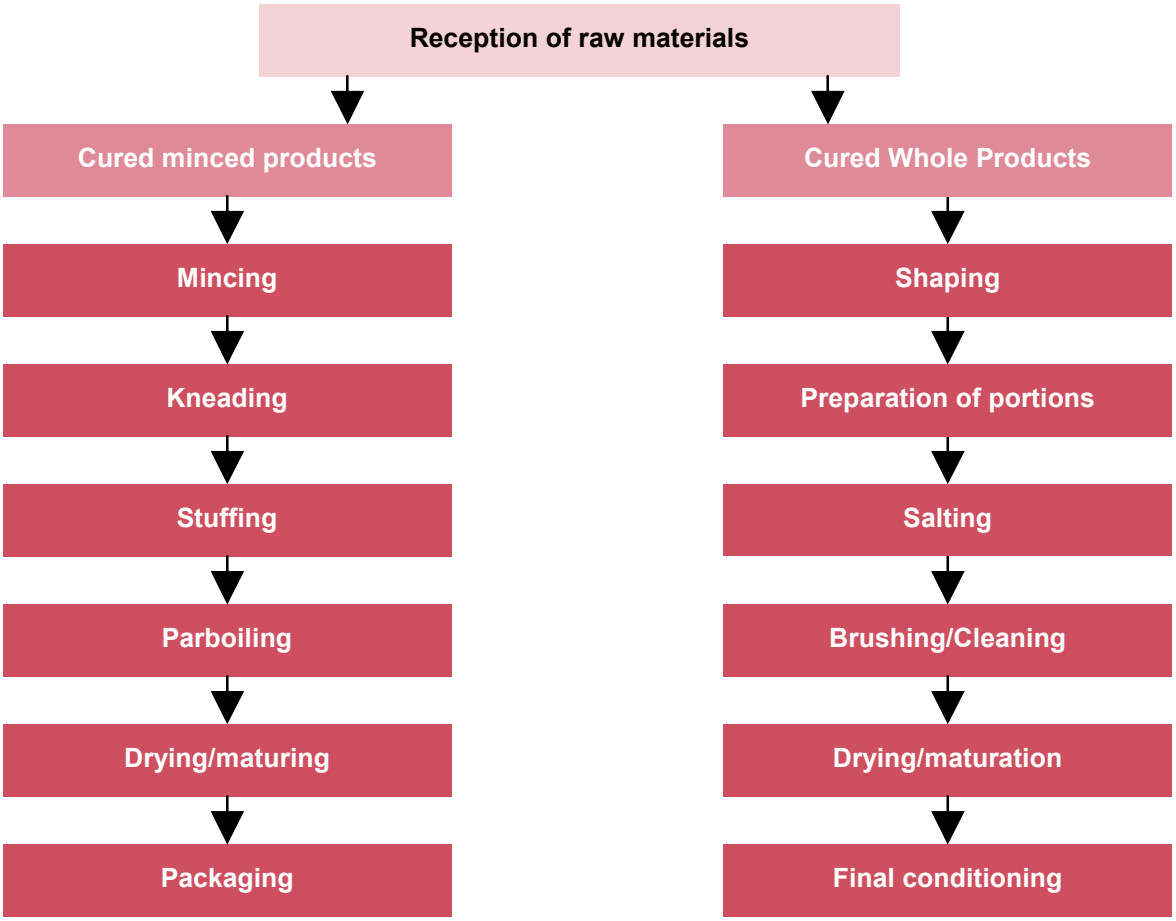


Figure 3.6: Flow diagram of operations of the production process for cured processed meats.

3.2.2.1. Cured processed meat from whole pieces

Cured products from whole pieces are usually made from beef or pork, the most well known being ham, pork shoulder and pork loin, as well as cured beef.

Spain and Italy are renowned for the production of these types of pork products, the consumption of which is widespread in all except Muslim countries, where in recent years cured beef and beef ham has started to be introduced.

These types of products are not usually made with chicken or turkey.

Shaping

The raw material that is generally used to make whole pieces of cured meat (ham and shoulder, loins, cured beef) is fresh meat that has been given a homogenous commercial form through shaping. On occasion, the piece is shaped in the processing plant itself, by removing superficial skin, subcutaneous fat and other elements to obtain the final presentation, in accordance with characteristic quality specifications.

Salting

Before the pieces are salted, they are subjected to a massage (manual or mechanical) to eliminate any blood that may have remained in the blood vessels. Moreover, pieces have to be refrigerated for at least 24 to lower their temperature below 4 °C.

The piece is then pre-salted, i.e. a salt-based preparation of nitrites, nitrates and other additives is applied. This may be applied manually, to the lean part of the piece, or mechanically in drums.

The pieces are salted in chambers at a temperature of between 1and 3 °C and a humidity of over 90 %. Is important to maintain a temperature of between 0 and 4 °C, as at lower temperatures the salt does not penetrate, and high temperatures favour microbial growth. The pieces remain in salt for 0.5-2 days per kilo of fresh meat.

The most commonly used systems of salting are stacking and in containers/trays.

Brushing/Cleaning

Once the salting time has expired, the salt is removed from the pieces, either manually or by using machines that spray the pieces with water at high-pressure to remove the adhered salt, allowing its re-circulation. Some types of equipment also have brushes which carry out or finish off this task.

Standing/post-salting

After cleaning, the pieces are hung on trolleys and placed in chambers at a temperature of 2-5 °C, and at a humidity of 75 to 80 %. The aim of this action is to attain a homogenous distribution of salt throughout the muscle mass. One way of determining the minimum time required for salting and standing operations (generally 45 days) is by controlling the loss of weight of the piece, which has to vary between 10 and 12 %.

Drying/maturation

During this stage, the piece undergoes a progressive loss of water, at the same time as it acquires its aroma and characteristic taste by means of enzymatic reactions. Drying has to be carried out in progressive stages, starting from 10-12 °C and up to temperatures no higher than 35 °C during the last 30 days of drying.

Drying chambers must operate under conditions of controlled temperature humidity and air speed, or pieces may be dried in natural drying sheds, were they are subject to the meteorological conditions of the location in question.

The normal drying time for a piece of ham is 8-9 months. In the case of Iberian ham, this stage may be as long as 24-26 months.

Final conditioning

Also referred to as parboiling, this consists of subjecting the pieces to duly controlled mild temperatures and relative humidities of 50-70 %, for a variable period of time (from a week to a month), with the aim of enhancing their aroma and taste.

3.2.2.2. Cured minced or restructured products

Cured minced or stuffed products are usually pork products, although recently they have also been made from beef. The most characteristic are *chorizo*, *salchichón*, salami and *fuet*.

As they are products that are chiefly made from pork, the principal countries in which they are consumed are those of the northern coast of the Mediterranean and the non-Muslim European countries.

Mincing

This is carried out with conventional mincing machines or with cutters. Mincing is carried out at between 7 and 1 °C, as minced meat is more susceptible to microbiological contamination. The mincing machinery can be refrigerated to avoid any friction in the machines increasing the temperature of the meat excessively. The meats that are used should be firm, with optimum water retention and absorbance capacity, and with pH values between 5.4 and 6.0. DFD meats are considered unsuitable, due to their excessive water retention capacity and their high pH; this is also true of PSE meats, due to their low absorbance capacity.

Kneading

This operation can be carried out jointly with the mincing. Here the minced meat is mixed with the fat, salt, spices carbohydrates, nitrates and nitrites, ascorbic acid and initiating cultures that are characteristic of the product. The mixture must be homogenous and the formation of cavities must be avoided, hence it is usually carried out under vacuum conditions.

Salt is the ingredient that is added in the greatest proportion (after meat), and contributes to the binding of the different particles of the minced meat, developing its texture and allowing greater protein solubilisation and its subsequent jellification. Besides its contribution to taste, it has a bacteriostatic action.

Carbohydrates are used to obtain proper fermentation and a suitable decrease in pH. Nitrites can be added directly or as nitrates; they play a role in the formation of colour, taste and aroma, and have antioxidant and antimicrobial effects. There are a number of problems related to their use, such as the formation of nitrosamines; for this reason, there are legal regulations on the quantities permitted.

Ascorbic acid is used as an adjuvant in curing, improving the colour, aroma and flavour of the product, as well as blocking the formation of the N-nitrosamines.

Meat initiating cultures are micro-organisms that are used to the following ends:

- Inhibition of pathogenic and altering micro-organisms.
- Partial or total digestion of food substances.
- Contribution to obtaining stable colour, taste and characteristic aroma and enhancement of cut resistance.
- Improves desiccation speed and homogeneity.

In addition to the above-mentioned ingredients, there are a whole series of additives that can be added to different ends, such as colouring agents, preservatives and flavour enhancers.

Stuffing

Using stuffing machines, the prepared meat paste is introduced into natural or artificial casings that are permeable to humidity. Occasionally, the paste is refrigerated (5-10 °C) for 12 to 48 hours before stuffing, for the multiplication of any initiating cultures or microbes already present to start, as well for any curing reactions.

Parboiling

This consists of increasing the temperature and humidity to accelerate the fermentation reactions that are characteristic of each type of coarse-cut meat. During this operation, basic pHs are maintained and a natural selection of bacterial growth is obtained. Parboiling usually lasts between 24 and 48 hours.

Drying/maturation

During this operation, the water content of the coarse-cut meats is progressively eliminated. Drying is initiated with a progressive increase in the parboiling temperature to 12-14 °C, with a drying time that may vary between 20 days and two months of curing. This can be carried out in natural drying sheds or in drying chambers with controlled temperatures, humidity and air speed.

Packaging

Due to the physicochemical transformations undergone during the previous stages, raw coarse-cut meats are stable at room temperature. In order to prevent them from continuing to lose interior humidity, or for reasons of hygiene, they can be wrapped in plastic (optionally vacuum-packed) and kept in a controlled atmosphere.

3.3. AUXILIARY PROCESSES

In the same way as in many industries, in order for meat processing plants or slaughterhouses to operate efficiently, the availability of a series of auxiliary services is highly important. We now go on to describe some of those which may have some type of impact on the medium through the environmental aspects that they generate.

- Generation of heat
- Generation of cold
- Water conditioning
- Waste treatment
- Maintenance of equipment, installations and services
- Cleaning and disinfection of equipment, installations and services

3.3.1. Steam generation

The majority of plants in the meat sector have steam boilers, which are principally used in:

- Slaughterhouses, fundamentally for pig scalding.
- Cooked meat processing plants, where steam and hot water are required in the cooking and pasteurisation processes.
- Cured meat processing plants and salt curing plants in drying chambers, to supply heat and for the desiccation of products.
- All workplaces for the sterilisation of knives and work utensils, as well as for the cleaning of installations.

In order to generate steam or hot water boilers located in separate buildings are used; these operate with the combustion of fossil fuels: gas oil, petrol, fuel oil, propane or natural gas, which produce, on the one hand, calorific energy which is used directly to generate steam and hot water, and on the other, emissions of volatile organic compounds (VOC), carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen oxides (NO_x), which are channelled and emitted into the atmosphere.

3.3.2. Refrigeration and freezing equipment

In meat processing industries, the requirements for the generation of cold for the operations of refrigeration, freezing and drying under controlled conditions are very high.

The refrigeration and freezing equipment that is generally used in the meat processing industry are classified as follows:

- Mechanical systems: these are closed systems that act as pumps, extracting heat from the foodstuff or from the area that is to be cooled, and transferring it to another area, where it is dissipated. This is done by using refrigerating fluids that circulate through a system in a closed circuit, successively transforming from liquid to vapour and vapour to liquid (halogenated hydrocarbons – freons – and ammonia). Properties of the refrigerating fluids that are worthy of mention include their low boiling points (lower than 0 °C), their high latent vaporisation heat, their low toxicity, non-flammability and their low cost. In mechanical systems, the cooling liquid does not come into direct contact with the food, and it cools other media, principally the air that refrigerates chambers, tunnels and refrigerated transport vehicles; liquids (generally water), for the production of ice; and the smooth surfaces (generally metallic) that form part of a fluid refrigeration interchanger.
- Cryogenic systems: These employ cryogenic liquids or liquid gases (N_2 and CO_2) which have very low boiling temperatures, and very high latent vaporisation heats. The foodstuff is chilled by direct contact with the cryogenic liquids, which absorb the heat from the foodstuff and evaporate or sublime, thereby cooling it down. One disadvantage of this technology that should be mentioned is its high cost, even though high-quality products are obtained.

3.3.3. Water conditioning

In meat processing plants, the water used for direct contact with the product, and for the cleaning and disinfection processes must be potable. The potability of water implies the presence of certain minimal levels of residual disinfectant, generally chlorine, in all circuits and storage tanks, due to which chlorination is recognised as a habitual treatment in these installations.

In the case of cleaning waters and in boiler systems, it is often necessary to treat the water supply in order to reduce its hardness and conductivity, which requires decalcification and deionisation treatments or filtering with active carbon. Depending on the type of treatment carried out, wastewater is generated with high levels of conductivity or extreme pH values, to a greater or lesser extent.

3.3.4. Wastewater treatment

Due to the high level of contamination in the wastewater, it must be treated to eliminate the contamination present.

The treatments that are described below are habitually used in the purification of wastewater.

3.3.4.1. Physicochemical treatments

These include the following operations and techniques which use physical or chemical processes for the elimination of the pollutant load:

1. Screening system: this operation consists of the physical separation, by means of bars, wires and rods, of any large objects that may damage equipment downstream (e.g. pumps flowmeters) or which may interfere in subsequent treatment processes. Screening can be classified as thick screening (over 40 mm), medium screening (10-40 mm) and fine screening (1-10 mm). The screens, in turn, may be manual cleaning, self-cleaning curved screen and self-cleaning sloped bar screen.

2. Sifting: consisting of the separation of small solids (0.1 to 1 mm) through the use of meshes or perforated plates. Sieves can be classified as static, rotational, graded or continuous.

   It should be mentioned that through the use of screening and sifting, it is generally possible to reduce suspended solids by approximately 90 %.

3. Degreasing: this consists of separating grease, oils and light particles through flotation and removal by skimming from the surface. If the fats are emulsified, they are separated by the addition of fine air bubbles and flocculants which help them to float.

4. Homogenisation: the aim of this procedure is to reduce fluctuations in the flow and loads towards subsequent processes, endowing them with the most constant characteristics possible. Homogenisation takes place in tanks, which are stirred and aired, and retention time for homogenising loads is usually 24 hours. Depending on the characteristics of the effluent, the homogenisation tank may in turn, serve to limit variations in pH and prevent unexpected waste (spillage from storage tanks, pump failure, etc.) reaching the purification system.

5. Neutralisation or pH adjustment: the modification of the pH of wastewater by means of neutralisation and pH control systems, with the aim of obtaining the alkalinity or acidity required for subsequent treatment or discharge.

6. Coagulation-flocculation: the aim of this stage is to eliminate colloidal particles (intermediate size between soluble particles and suspended particles) which are difficult to treat with other physical methods.

   The use of coagulation results in the destabilisation of colloids by adding chemical agents called flocculants to the wastewater. These favour the aggregation of destabilised particles, forming flocculates which can be easily separated from the water. Factors that affect the process include:

   - The velocity gradient
   - Contact time
   - pH

7. Clarification: a process consisting of the separation of flocculates or sludge from the aqueous phase by means of:

   - Sedimentation with decanters for the extraction of dense flocculates.
   - Flotation, which may be natural and occurs with particles that are less dense than water (e.g. fats), or by means of air flooding, which increases the velocity at which these particles rise.

Moreover, with particles that are somewhat heavier than water it is possible to create clusters of particles with bubbles which float easily and can be extracted by flotation. This is called induced flotation.

It should be mentioned that, after the clarification process, a number of sludge treatments are necessary, and habitually involve the use of a thickening equipment, to concentrate the sludges, and a system of desiccation (press, band filter or centrifuge).

3.3.4.2. Biological treatment

Biological systems are used to reduce the organic load of the effluent from meat processing plants via the action of micro-organisms.

Biological treatments may be aerobic or anaerobic, depending on the presence or not of oxygen. In the meat processing industry, more specifically in slaughterhouses, the most common installations are aerobic systems, or a combination of aerobic and anaerobic systems.

Depending on the support for the growth of micro-organisms, biological systems can be made up of suspended biomass, in which the micro-organisms form suspended flocculates, or fixed biomass, in which the micro-organisms are bound to a support material, forming a bio-film.

In biological systems with suspended biomass, the most common method in the aerobic treatment of process waters is that of activated suspended sludges, in which the micro-organisms present in the sludge degrade the dissolved organic material through the use of oxygen. The treatment consists of a reactor, a mixing system, an oxygen supply system and a decanter for recovering the sludges and re-circulating them to the reactor.

Biological systems with suspended biomass can also be anaerobic. In this type of system, organic material is degraded via fermentation in the absence of oxygen. The treatment consists of an anaerobic biological reactor, a mixing system, a degasser and a decanter for recovering the sludges and re-circulating them to the reactor.

In biological systems with fixed biomass, the following systems are worthy of mention:

- Rotational biological contactor (bio-discs): an aerobic system consisting of a series of polystyrene or PVC discs on a spindle. The discs are partially submerged in the wastewater and rotate slowly in it.
- Biological filters: aerobic or anaerobic system comprising a tank with a filling that acts as a support for the micro-organisms.

After the aerobic biological process, it is also necessary to implement a line of treatment for sludges, as in this treatment they are usually generated in abundance. This usually consists of a thickening unit to concentrate the sludges and a desiccation system (press, band filter or centrifuge).

3.3.4.3. Specific treatments

In certain cases, it is necessary to eliminate compounds of nitrogen, phosphorus and organic material of low biodegradability from wastewater by means of specific treatments. The type of treatment will depend on where the waste from the plant is discharged, or on whether the treated water is to be reused.

3.3.5. Maintenance of equipment, installations and services.

One of the functions necessary to ensure the correct operation of installations and equipment involves maintenance operations. During these maintenance operations, the principal residue generated includes packaging and scrap, along with other more dangerous ones, such as used oils, greases, lubricants, fluorescent tubes, batteries, dangerous packaging, etc.

3.4. CLEANING AND DISINFECTION

The risk of microbiological preparation for meat products, in both the product and the surfaces in contact with it, is considered high, given their biological and functional characteristics, amongst which we should mention their high degree of nutritional power and their high water activity.

In meat and, thus in recently prepared minced meat, *Lactobacillus*, micrococacea, enterobacteria, *Leuconostoc*, certain species of the genera *Clostridium*, *Pediococcus*, *Achromobacter*, *Flavobacterium*, *Bacillus*, enterococci, etc., molds and yeast can be found. With regard to pathogenic micro-organisms, *Clostridium*, *Listeria monocytogenesis*, *Staphylococus aureus*, *Salmonella sp*. *Yersina enterocolitica, Escherichia coli O157,H7* and *Campylobacter jejuni* have been detected.

With the exception of the outer surface of the digestive and respiratory tracts, tissue from healthy animals contains few micro-organisms. There are various sources of meat contamination during the

preparation of the carcass, such as contact surfaces (equipment, tools, knives), handlers, water, and the animal itself due to inadequate sanitary dressing. On the other hand, the contamination of processed meat products will depend to a great extent on that of the meat and of the ingredients used, and on the hygienic state of equipment, tools and the individuals involved in handling them.

Due to the high risk of microbiological contamination with meat products, operations of industrial hygiene, with regard to both handlers and installations, acquire special relevance; these include the processes of cleaning and disinfection.

One of the principal objectives of industrial sanitation is that of minimising the risk of contamination to processed meat products to certain levels that make it possible to ensure an acceptable microbiological quality, in accordance with public-health hygiene requirements, by means of the following:

- The clearing of installations and equipment in order to eliminate, as far as possible, the remains of organic and inorganic material from surfaces, including cross-contamination by allergens.
- Disinfection of installations and equipment to eliminate contaminating micro-organisms as far as possible.
- Staff hygiene, to avoid contamination during handling of the product.

3.4.1. Staff hygiene

Staff handling foodstuffs supposes a potential risk of contamination for the product, due on one hand to the possibility of the transmission of micro-organisms to the product, and on the other, as a cross contamination vector during the handling of the product.

With the aim of minimising the risk of contamination, staff handling foodstuffs have to provide proof (in the form of a medical certificate) that they have no infectious diseases that can be transferred to the foodstuff, and they must be qualified via training in matters pertaining to industrial hygiene in their place of work.

3.4.2. Cleaning and disinfection of equipment, tools and installations

The equipment, tools and installations used in the processing of meat must be cleaned and disinfected systematically, according to a defined programme, and with a high frequency that is evaluated according to the maximum concentration admissible of organic material and micro-organisms on their surfaces.

As premises of the cleaning and disinfection process, in order to avoid contamination of the product due to cross contamination, the following elements must be taken into consideration:

- The hygienic design of equipment and installations.
- The type of dirt or residue related to the manufacturing process.
- The mechanical energy of the cleaning that is applied.

With regard to the hygienic design of equipment, it should be pointed out that it must be possible to dismantle the process equipment, and there must be easy access for its cleaning and supervision; its composition must be compatible with the characteristics of the product and the chemical cleaning and disinfecting agents (stainless steel, elastomers, Teflon, etc.), and it must be finished off with smooth surfaces.

Furthermore, installations must have impermeable walls, floors and groups with hygienic joints.

3.4.3. Cleaning and disinfecting products

3.4.3.1. Cleaning water

The water used in cleaning processes must be potable, and as an important measurement of quality for its use as a cleaning product, its level of hardness must be taken into account; this is defined as the concentration of calcium and magnesium expressed as calcium carbonate in milligrams per litre of water.

The classification of water hardness can be carried out in accordance with the following parameters:

Degree of hardness of water	Concentration in mg/l
Soft	0-51.3
Medium	51.3-119.7
Hard	119.7-179.5
Very hard	> 179.5

Source: *US Geological Survey Water Hardness Data*.

Soft water is preferred for the process of cleaning and disinfection, due to the fact that the levels of hardness interfere in the solubility and activity of detergents and disinfecting agents - insoluble films arising from the reaction of detergents and soaps can form, and calcium deposits can also be generated on the surfaces to be sanitised.

If the characteristics of water hardness are not suitable, they can be conditioned by means of treatments that eliminate magnesium and calcium ions.

3.4.3.2. Detergents

Detergents and cleaning agents are often a mixture of ingredients formulated to react with dirt, by means of physical or chemical mechanisms.

Due to their physical action, clearing agents are generally classified into five types: basic alkalines, phosphate complexes, surfactants chelating agents and acids.

Worthy of note as cleaning agents in meat production processes are surfactants. These are widely used, and their function is related to the activities of dispersion, emulsion, penetration, foaming and moistening of dirt.

Surfactant agents are classified into two types: ionic and non-ionic (anionic), the latter being compatible with both alkaline and acid detergents.

Due to their chemical action, cleaning agents are generally classified into acid and alkaline detergents.

Acid detergents use the hydrogen ion $(H)^+$ as an active ingredient to break down the molecules of dirt, so that they can be dissolved in the cleaning solution.

Acid detergents are used to eliminate mineral deposits, and are generally corrosive to metals, particularly galvanised iron and stainless steel.

Alkaline detergents are the most widely used in the meat production sector, given that they combine with greases to form soaps, and with proteins to form soluble compounds that can be easily eliminated with water.

Worthy of note among alkaline detergents is sodium hydroxide (NaOH), which is highly alkaline, and sodium carbonate, of medium alkalinity and which is a common ingredient in many cleaning compounds.

Important factors when choosing cleaning agents are they type of dirt to be eliminated, the finish and characteristics of the surfaces to be cleaned, the temperature of washing, exposure time or washing time, and the force applied or quantity of stirring required to clean.

3.4.3.3. Disinfectants

The main objective of disinfectants is the reduction to acceptable levels of undesired micro-organisms on the surfaces of equipment, tools and installations.

Thermal disinfection of equipment and tools is a habitual practice, and for disinfection with hot water at a temperature of 82 °C, an exposure time of approximately 20 minutes is recommended.

With regard to disinfection with chemical methods, chemical products approved for use in food processing operations are used. In the majority of countries chlorinates, iodophors and quaternary ammoniums are permitted as disinfectant agents.

Chlorinated compounds have a broad antibacterial spectrum, are widely used (especially bleaching soda) and are relatively cheap. The effectiveness of chlorine is affected by the concentration of hydrogen (pH), temperature, and the organic load of the medium. The principal disadvantages of chlorine include that fact that it is corrosive, and that its handling entails a risk of toxicity.

Iodised compounds are active against bacteria, yeasts, molds, protozoa and viruses. Nevertheless, they have the following disadvantages: they evaporate at 49 °C; they stain treated surfaces, especially plastics; they are sensitive to organic materials; they are corrosive to stainless steel 304 if used at concentrations in excess of 1 %; and they are relatively costly.

Quaternary ammoniums have a number of properties, such as moisturising, solubilising, softening and anti-bacterial powers. They are reducing agents, and thus, are not oxidants. The cationic nature of quaternary ammoniums makes it advisable not to formulate them together with anionic surfactants, and it must also be stressed that they are foamers. Among their advantages is the fact that they are low toxicity bactericides and fungicides of moderate cost.

In the use of disinfectant agents, periodical rotation in the use of products is advisable, in order to avoid the appearance of strains of micro-organisms that are resistant due to the prolonged use of a single disinfectant.

3.4.4. Cleaning and disinfecting plans

The aim of cleaning and disinfectant plans is to maintain the hygienic state of installations within acceptable values, in order to minimise the risk of the chemical, physical and microbiological contamination of processed and manufactured products.

Cleaning plans are installation-specific, and for each of the plants, types of equipment and tools used include the following:

- A classification of the type of dirt and micro-organisms present.
- Acceptable levels of contamination.
- Cleaning and disinfecting products to be used.
- Cleaning and disinfecting procedures.
- Evaluation of the effectiveness of the cleaning and disinfection procedures.
- Control plan for the effectiveness of the cleaning and disinfection.

In turn, cleaning and disinfecting procedures must include, among others, the following elements:

- The frequencies of cleaning operations.
- Description of the cleaning operations, specifying the tasks, sequences and activity times, utensils to be used, and specifications of the parameters to be controlled (e.g. water temperature).
- Detergents and disinfectants to be used, dosing, rotation and actuation time.
- Individuals responsible for carrying out the tasks.
- Safety instructions for the equipment and products used.

The cleaning and disinfecting operations that are described in the procedures, in turn, generally include the following temporally linked activities:

1. Dry cleaning, by means of the removal of coarse dirt that is not adhered to surfaces, using brooms and brushes to facilitate its elimination wherever necessary. In this stage the use of high-pressure water for removal is not advisable, due to the risk of cross-contamination as the dirt is moved from one point of the installation to another, and the organic load of the wastewater generated will increase considerably.
2. Pre-soaking with high-pressure hot water, in order to remove dirt to certain pre-established levels (e.g. no visual evidence of remaining dirt). In meat processing, it is generally advisable to apply medium pressure (20-60 bar), in order to avoid the production of mists and avoid cross contaminations, and to use hot water (46 °C) to facilitate the elimination of greases and to avoid denaturing proteins.
3. Application of foaming alkaline detergents, with an average contact time of 15 minutes.
4. Rinsing with hot water at medium pressure, to solubilise dirt and eliminate any remaining detergent from surfaces.
5. Application of disinfectant on services, generally via spraying, with a determined contact time in accordance with the type of disinfecting agent.
6. Rinsing with water at medium pressure, before starting the production process, to eliminate any disinfectant that may remain.
7. Drying of all surfaces in contact with the product, to avoid generating a humid medium favourable to microbial growth.

3.4.5. Cleaning equipment and systems

Cleaning can by carried out either manually or in an industrial mechanised manner: cleaning and disinfecting with foam and high-pressure rinsing.

Manual cleaning

In manual cleaning the processes of brushing and immersion/soaking must be mentioned.

On occasion, manual cleaning with brushes is necessary for dismantled equipment, such as cutters. Considerable mechanical force is obtained with brushing, which is used applying a detergent solution at between 35-40 °C. Brushes must be made of an impermeable material, generally plastic, and these in turn must be periodically cleaned and disinfected - this being one of the factors that limit their industrial use.

The immersion or soaking process consists of leaving the material in detergent or disinfectant solutions for a stipulated time. This process is used for the sanitising of moulds, trays, trolleys, etc. This technique is being replaced by automatic washing tunnels, in which water, detergents and

disinfectants are applied using sprinkler showers with nozzles. Detergent solutions and rinsing water can be re-circulated and reused, allowing savings to be made.

Mechanised industrial cleaning

With regard to cleaning carried out industrially, special mention should be made of equipment for the application and dosing of water, detergents and disinfectants, which can be divided into the following:

1. Equipment for projecting water and foam at high pressure (120-150 bar). This system is used in areas that are very dirty or which are difficult to reach. It is a rapid cleaning system, but which has many drawbacks, since:
   - Mists and aerosols are produced, resulting in high risks of malfunction in control panels, and of microbiological cross-contamination.
   - Larger quantities of water and energy are used.
   - It is difficult to handle, as the jet that is produced is too strong (high levels of return force are produced), and it is noisy for the personnel.
2. Equipment for projecting foam at medium pressure (20-60 bar). In this system, the detergent is sprayed onto surfaces in the form of a continually dispensed thick foam, with an actuation time of 15-20 minutes. This system is commonly used in the meat processing sector, due to its numerous advantages:
   - It does not produce mists or aerosols; hence the risk of microbiological cross contamination is reduced.
   - It cuts down on the use of water, cleaning products (optimal use thanks to prolonged contact between the foam and the dirt) and energy.
   - It is easy and convenient to use.

3.4.6. Pest control plan

One of the dangers for the contamination of foodstuffs is the presence or introduction of animals or insects, through different pathways, into the manufacturing areas. In order to reduce the risk of contamination, companies have to adopt preventative measures and pest eradication/control systems.

3.5. MEAT BY-PRODUCTS AND WASTE

In the control of meat by-products and waste the entire internal management process materials must be taken into account, ranging from the characterisation, classification and quantification of the by-product or waste, the pattern of generation, conditions of collection, storage and conditioning, to their being handed over to an authorised waste manager.

3.5.1. Characterisation and quantification

The characterisation of by-products or waste consists principally of determining their legal classification within the framework of existing legislation. To a great extent, this classification will determine the conditions of their collection, storage and conditioning as well as their final management.

Two types of waste material can be identified in meat processing industries: those deriving from the handling of raw material, and all other waste that is related to the production process, such as cardboard, plastics, wood, hazardous waste (cleaning and maintenance) or organic waste that is treated as urban waste.

Once the waste has been classified, it must then be quantified by means of mass balances or directly by measurement on weighing machines; these values must also be given in the documents certifying their handing over to an external waste manager.

At the end of this chapter, by way of example, is a table summarising the classification of meat-processing waste according the European Waste Catalogue (EWC) list.

3.5.2. Collection, storage and conditioning in the facilities

In order to separate waste at source, it must be suitably collected, stored, and if necessary, identified to facilitate its final management. In some cases it may be possible to condition the waste (dehydration, pressing, etc.) to improve the conditions of final management.

3.5.3. Organic by-products

By-products of an organic nature constitute the largest group of by-products in the meat processing sector. In accordance with EEC Regulation 1774/2002, by-products can be classified into three categories, referred to as “Category 1, 2 or 3 material”, depending on the case in question. For each category of by-product different authorised destinations are stipulated.

An external evaluation of the organic by-products can be made, or other alternatives may be applied, including composting with other materials, bio-methanisation, gasification or the obtaining of value-added substances for the agrifood, chemical and pharmaceutical industries.

3.5.4. Hazardous waste

Hazardous waste is principally generated in the maintenance of equipment and installations, and in the cleaning and disinfecting of equipment, installations and utensils.

The most relevant are usually containers that have held hazardous substances, used oils, solvents, fluorescent tubes, batteries, and others, such as laboratory waste. These types of waste are well identified in the European Waste Catalogue.

3.5.5. Other types of waste

Meat processing industries also generate waste that is classified as non-hazardous, and which can be considered as similar to municipal solid waste.

Included in this category of waste are plastic, cardboard, paper, metals and wood, produced principally in the unpacking of raw and auxiliary materials and the packaging of end products, along with waste from cafeterias, dining rooms and gardening, as well as others, such as office material.

Table 3.1: Summary of the classification of meat-processing waste according to the European Waste Catalogue (EWC)

WASTE				
Description of WASTE	**Code EWC**	**CLA**	**VAL**	**TRR**
Animal faeces, urine, slurry and waste that is selectively collected and treated away from the place in which it was generated	020106	Non-hazardous	V81, V83, V85	
Washing and cleaning sludges	020101	Non-hazardous	V81, V83	T33, T24, T12
	020201			T24, T31, T33
Animal tissue waste	020102 020202	Non-hazardous	V31, V38	T36, T12, T21
Materials not suitable for consumption or processing	020203	Non-hazardous	V33, V31, V61, V85, V82, V83	T36, T31, T12
Specific risk material	180202	Hazardous	V31	T34, T23, T22
Sludge from in-situ waste treatment	020204	Non-hazardous	V81, V83, V85	T33, T24, T12
Plastics	200139	Non-hazardous	V12, V61	-
Paper and cardboard packaging	150101	Non-hazardous	V51	T21, T13, T36
Plastic containers	150102	Non-hazardous	V51	T13, T21, T36
Wood containing no hazardous substances	200138	Non-hazardous	V15, V61	T12
Containers with residue of hazardous substances, or which have been contaminated by them	150110	Hazardous	V51	T21, T36, T13
CFC, HCFC and HFC	140601	Hazardous	V21, V24	T22
Mixtures of municipal waste	200301	Non-hazardous	-	T12, T21, T36
Hydraulic oils	130111 130112 130113	Hazardous	V22	T21
Fluorescent tubes	200121	Hazardous	V41	-

List of abbreviations	
VAL:	Ways of recovery.
TRR:	Treatment and rejection regulations.
V11:	Recycling of paper and cardboard.
V12:	Recycling of plastic.
V15:	Recycling and reuse of wood.
V21:	Regeneration of solvents.
V22:	Regeneration of mineral oils.
V24:	Recycling of organic substances.
V41:	Recycling and recovery of metals or metal components.
V43:	Regeneration of acids or bases.
V46:	Recovery of photographic products.
V51:	Recovery, reuse and regeneration of packaging.
V54:	Recycling.
V61:	Recycling of toners.
T11:	Disposal of inert waste.
T12:	Disposal of non-special waste.
T13:	Disposal of special waste.
T21:	Incineration of non-halogenated waste.
T22:	Incineration of halogenated waste.
T24:	Treatment by evaporation.
T31:	Physicochemical and micro-biological treatment.
T32:	Specific treatment.
T33:	Stabilisation.

4. ENVIRONMENTAL ASPECTS OF THE MEAT PROCESSING INDUSTRY

The environmental aspects of the meat industry are identified as those activities which are carried out therein, and which interact with the environment. When these activities give rise to changes in the environment, these are called environmental impacts.

The principal environmental aspects and impacts generated in the meat sector are those relating to:

- Wastewater
- Waste
- Atmospheric emissions
- Noise
- Energy consumption
- Water consumption

Slaughterhouses constitute an activity sub-sector with a high environmental impact.

The table below summarises the most significant environmental aspects of the meat industry.

Processes	Activity[1]				Environmental aspect[2]					
	S	CP	PA	MP	WW	W	EM	N	EC	WC
Reception of raw materials		X		X		X				
Lairaging	X				X	X		X		X
Reception and lairaging of poultry			X		X	X		X		X
Stunning	X		X		X				X	X
Bleeding	X		X			X		X		
Scalding	X		X		X	X	X		X	X
Cutting and dehairing	X				X	X			X	X
Plucking			X		X	X			X	X
Leg and head removal	X		X			X			X	
Evisceration	X		X		X	X				
Rinsing of carcasses	X		X		X					X
Rinsing and conditioning of casings (intestines)	X		X		X	X	X			X
Cutting		X		X	X	X				
Carving				X		X			X	
Mincing				X		X			X	
Stuffing				X	X	X			X	X
Injection and massage				X					X	X
Salting				X		X				
Cooking				X	X		X		X	X
Cooling				X	X		X		X	X
Drying				X					X	
Refrigeration/Freezing	X	X	X	X				X	X	
Packaging		X	X	X		X				
Cleaning of equipment and installations	X	X	X	X	X					X
Collection and storage of waste	X	X	X	X		X	X		X	
Wastewater treatment	X		X	([3])	XX				X	

[1] S, slaughterhouses; CP, cutting plants; PA, poultry slaughterhouses; MP, meat products.

[2] WW, wastewater; W, waste; EM, emissions; N, noise; EC, energy consumption; WC, water consumption.

[3] According to production.

4.1. WATER CONSUMPTION

The principal types of water consumption in the meat industry can be classified on the basis of the type of activity, as specified in the table below:

Table 4.1: Water consumption in the meat industry classified on the basis of activity type

Type of activity	Principal consumption of water
Slaughterhouses	• Cleaning and disinfection of equipment, installations and services. • Washing throughout the production line, from washing the animals in stables to the washing of the finished edible parts (carcasses and giblets). • Pig scalding and other operations associated with the elimination of pig hair and skin.
Cutting plants	Water is used in the majority of operations for cleaning and disinfecting equipment, installations and work utensils.
Processed meat products	The main consumption of water is in cleaning and disinfecting equipment, installations and work utensils. Other operations in which water is consumed are the following: • Cooking and subsequent cooling of products when water-based techniques are employed. • Thawing of raw material when water-based techniques are employed. • Refrigeration system for cooling equipment. Consumption will depend on whether the circuit is open or closed. In the case of closed circuits, there are losses due to evaporation in evaporative condensers and cooling towers. • Desalting of pieces.

The following table gives an example of consumption in a meat processing plant, given that consumption may vary according to the type of installation.

Table 4.2: Example of the breakdown for water consumption in a meat processing plant

Process	% total consumption
Lairaging	25
Slaughter and evisceration	10
Washing of carcasses and offal	20
Conditioning of by-products (fats, proteins, etc.)	2
Washing and cleaning stations	10
Washing (hands, boots, aprons, etc.)	7
Cleaning of the plant	22
Services in the plant (condensers, cooling towers, water for boilers, etc.)	4
Total	**100**

Source: *Collation of Data from MLD, 1995b,* and *International Data of the UNEP Working Group for Cleaner Production*.

With regard to the use of water:

1. Forty percent of water consumed is hot water.
2. Fifty percent of water consumption in facilities is fixed, and is independent of the production ratio.
3. Sixty percent of water consumption depends on the practices of the operator (cleaning with hosepipes, manual cleaning of products and equipment, etc.)
4. The most modern facilities are the easiest to clean due to better layout and equipment design, resulting in considerable reductions in water consumption.

The following figures indicate water consumption and the distribution of consumption in slaughterhouses:

Table 4.3: Water consumption in multipurpose slaughterhouses

Average water consumption (l/article)	
Cattle	500-1,000
Pigs	250-550
Poultry	8

Table 4.4: Examples of estimated relative water consumption in two pig slaughterhouses in the UK and Denmark

	Relative water consumption (% of total)	
	United Kingdom	Denmark
Cleaning of installations and equipment	33	35-55
Cleaning of vehicles	5	5
Cleaning of stables	3	5
Sterilisation of utensils	5	10-15
Washing of product	31	30-35
Scalding	7	3
Cooling water	6	5
Sanitary water	10	
Boilers		2

Source: *BREF on BATs in the Slaughterhouses and Animal By-products Industries.*

4.2. ENERGY CONSUMPTION

The principal sources of energy consumption are the generation of heat energy for the production of steam and hot water, as well as the refrigeration installations.

In Spain, the consumption of electricity in slaughterhouses is between 55 and kWh/t of carcass, and includes, besides the consumption due to refrigeration, that of compressed air and wastewater treatment.

The most common means of transporting heat energy in slaughterhouses is hot water, and to a lesser extent, steam, and the different parts of the installations are supplied from the boiler plant.

By way of example, the following table shows the consumption of heat energy relative to the principal operation carried out in a cattle slaughterhouse.

Table 4.5: Distribution of heat consumption in a Danish cattle slaughterhouse

ACTIVITY	% of consumption
Heating of installations	13 %
Heating of water, total Water to 40 °C Water to 60 °C Water to 82 °C	80 % 5 % 54 % 21 %
Calorific loss	7 %

Source: *BREF on BATs in the Slaughterhouses and Animal By-products Industries.*

With regard to electricity, the main points of consumption are refrigeration and freezing plants, which jointly account for approximately half the total electricity demand.

The following table shows a breakdown, by activity, of the approximate electricity consumption in a cattle slaughterhouse.

Table 4.6: Distribution of electrical consumption in a Danish cattle slaughterhouse

Activity	% of consumption
Refrigeration plant	45 %
Generation of compressed air	10 %
Lighting	10 %
Conditioning of equipment	10 %
Ventilation	5 %
Various	20 %

Source: *BREF on BATs in the Slaughterhouses and Animal By-products Industries*.

In wastewater treatment plants electricity requirements may be very high, especially where aerobic systems are employed.

On the other hand, in meat processing plants, the electricity consumption is concentrated principally in cooking and pasteurisation operations.

4.3. WASTEWATER

The most significant environmental aspect of the activity of slaughterhouses is the generation of wastewater, due both to the high volume generated, and the high pollutant load associated with them. The most significant environmental parameters correlated with wastewater are suspended solids (SS), the organic load expressed as the chemical oxygen demand (COD) and the five-day biological oxygen demand (BOD_5), oils and greases (O and G), total nitrogen and phosphorus (TN and TP), salts, as well as detergents and disinfectants.

With regard to the quantity of wastewater generated in slaughterhouses, between 80 and 95 % of the total water consumed forms part of the final effluent.

Of those parameters defined in the characterisation of wastewater from slaughterhouses, the principal sources are given in the table below:

Table 4.7: Principal parameters and sources of contamination of wastewater from slaughterhouses

Parameters	Principal sources
Organic Material (COD, COT)	Blood, scalding water, slurry/manure, stomach contents, etc.
Suspended solids,	Slurry/manure, stomach contents, hairs and waste meat.
Oils and greases	Scalding water and washing of carcasses
Ammonium and urea	Slurry/manure and blood.
Phosphates, nitrogen and salts	Slurry/manure, stomach contents, blood, detergents and disinfectants.
Detergents and disinfectants	Detergent and disinfecting products
Electrical conductivity	In those slaughterhouses with treatment and preparation of intestines, there may be high conductivity if significant amounts of salt were lost from that used to salt them, or if hides from slaughtered cattle were to be salted.

The following tables show the ranges of variation and the mean concentration values for the principal chemical parameters of wastewater from slaughterhouses (Source: Guide to the BATs available in Spain for the meat sector).

Table 4.8: Characteristics of wastewater prior to purification treatment in slaughterhouses (data in ppm)

	Max	Min	Mean
COD (mg O_2/l)	35,000	774	10,259
BOD (mg O_2/l)	5,350	500	2,550
SS (mg/l)	5,000	220	2,102
O and G (mg/l)	1,200	23	474
TN (mg N/l)	750	48	252
TP (mg P/l)	90	10	40
Cl (mg Cl/l)	1,000	649	825
pH	8	6	7

Table 4.9: Characteristics of wastewater prior to purification treatment in affected installations (data in kg/t carcass)

	Max	Min	Mean
COD	32.0	0.9	17.2
BOD	11.5	0.6	5.3
SS	11.9	0.2	7.1
O and G	2.6	0.0	0.9
TN	1.6	0.1	0.6
TP	0.2	0.0	0.1
Cl	2.2	0.7	1.4
$NH4^+$	0.5	0.2	0.4

In general, 80 to 95 % of the total water consumed forms part of the final effluent, and high concentrations are found in organic material, oils and greases, and suspended solids.

With regard to the biodegradability of wastewater (see list in the following table), with the data from the table of characteristics for wastewater from slaughterhouses a low value of biodegradability is obtained, although it is generally considered that wastewater from slaughterhouses is biodegradable.

Table 4.10: Degree of biodegradability according to the ratio between BOD_5 and COD (adapted from Metcalf & Eddy, 2003)

BOD_5/COD ratio	Degree of biodegradation
If BOD_5/COD < 0.2	Low biodegradability
If 0.2 < BOD_5/COD < 0.4	Biodegradable
If BOD_5/COD > 0.4	Highly biodegradable

4.4. WASTE

The principal waste generated in the meat industry can be classified as follows:

- Organic by-products
- Hazardous waste
- Specific risk material
- Waste treated as urban waste

4.4.1. Organic by-products

Manure, slurry in the reception and lairaging stage, blood and waste-treatment sludges (difficult to manage due to their high humidity and their high level of putrefactiveness), along with whole carcasses, animal parts or animal products that are not fit for human consumption constitute the principal organic waste generated in slaughterhouses.

In cutting plants, the main residue generated comprises un-sellable cuts of meat, and in the meat processing industry, products that do not conform to quality requirements.

4.4.2. Waste treated as urban waste

The meat processing industry generates waste that is treated as urban waste, mainly in the supply of raw and auxiliary materials, and in the packaging of finished products.

Table 4.11: Generation of waste treated as urban waste in processing plants

Material	Mean generation	Maximum generation
	kg/t of processed product	
Glass	3.80	7.61
Plastic	11.89	97.36
Cardboard	27.76	415.82
Meat	12.63	97.28
Wood	7.22	37.50
General	41.15	157.23

Source: Ainia.

Although in smaller quantities, slaughterhouses also generate waste treated as urban waste, in meat products.

Table 4.12: Generation of waste treated as urban waste in slaughterhouses

Material	Production kg/t of carcass
Plastic	0.6
Cardboard	3.7
Meat	0.2

Source: Ainia.

4.4.3. Hazardous waste

Hazardous waste is principally generated in maintenance of equipment and installations. These include used oils, solvents, residue from hazardous packaging and fluorescent tubes, and must be processed by authorised waste managers.

4.5. ATMOSPHERIC EMISSIONS

The main atmospheric emissions are generated in the production of hot water/steam, and during scalding and cooking, and are principally made up of the combustion gases CO_2, NO_X, SO_X and CO.

CO_2 emissions are directly related to the consumption of heat energy. The quantity of CO_2 will depend on the specific consumption of fuel.

The emission of NO_x is related to the composition of the fuel, and to the combustion conditions (combustion temperature, excess air, type of flame, the geometry of the combustion chamber or the design of the burner).

SO_2 emissions depend principally on the type and composition of fuel. Installations that use only natural gas produce no or negligible sulphur emissions. Those using fuel oil emit the sulphur contained in the fuel. The majority of installations currently consume low-sulphur fuel oil, with a sulphur content lower than 1 %.

Emissions of CO are insignificant in the meat sector, and are associated with the incorrect operation of boilers or incomplete combustion.

4.6. NOISE

The generation of noise in the meat industry is principally related to the reception, lairaging and slaughter of livestock, refrigeration equipment and automated transport systems.

If the slaughterhouses are located close to residential areas or other noise-sensitive zones, the noise generated by the manufacturing equipment and the manoeuvring of lorries during the reception of cattle and collection of by-products may be a nuisance. Potential problems should be taken into consideration when choosing a location for the plant.

As these are not companies with high levels of noise generation, in the majority of cases, the application of technical measures will suffice; e.g. fitting of mufflers to respect the permitted limits.

The following measures can be applied to reduce noise:

- Fitting of mufflers in ventilation systems
- Insulation of machines
- Soundproofing of walls
- Taking the prevailing wind direction with regard to important sources of noise into account at the planning stage.

5. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN THE MEAT PROCESSING INDUSTRY

In the meat processing industry, large quantities of water and energy and consumed, while significant amounts of effluent and waste are produced. From the point of view of pollution prevention and reduction, the main opportunities outlined in this guide focus on:

- Reducing water consumption in production processes and in cleaning and disinfection processes.
- Reducing energy consumption.
- Reducing the pollutant load of wastewater.
- Separating waste currents to facilitate their subsequent recovery.
- Optimising wastewater treatment processes.
- Recovering by-products and waste.

In addition to environmental criteria, hygiene and sanitary requirements have been taken into account, together with product quality, available technology and economic viability, in developing possible prevention actions.

The actions proposed as Pollution Prevention Opportunities (PPO) are outlined below. The actions are presented in a table in which the type of action, the process in which this action is relevant and the improvement to be achieved by putting the action into practice are also classified.

The actions are classified as outlined in the following table:

PPO Classification	
Process modification	PM
Incorporation of new technologies	NT
Raw materials substitution	RMS
Implementation of good housekeeping practices	GHP
Implementation of good housekeeping practices in relation to hygiene	GHPH
Recovery	R
Treatment	T

5.1. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN REFRIGERATED OR LOW-CAPACITY SLAUGHTERHOUSES

Improvement actions	Processes	OPP	Improvement obtained
Cleaning and disinfection of waiting or ramp areas for live animals and transportation vehicles In slaughterhouses, the dirtiest areas are the delivery and waiting areas and ramps for live animals, together with the animal transportation vehicles. Cleaning these zones requires large amounts of water to remove and carry away solid waste, composed mainly of manure, bedding materials and dust. Therefore the use of high-pressure water systems (18-25 atm) allow significant reductions in water consumption, at the same time creating lower levels of wastewater. This pressure is obtained through portable water pumps to which cleaning hoses are attached. According to one example in the BREF, water consumption using this technique is of 6 l/pig (78 l/t of pig carcasses) and 25 l/cattle unit (100 l/t cattle carcasses), while consumption for less effective methods is 10 l/pig and 80 l/head of cattle respectively.	Lairaging	GHPH	Reduction in water consumption. Reduction in wastewater generation.
Minimising water consumption during animal lairage During the lairage period of the animals, a sufficient water supply must be provided, avoiding excessive provision that will result in both high and unnecessary consumption and in the discharge of this excess water as a waste flow. When the animals are in lairage, there is a series of techniques that can be applied to enable a reduction in water consumption and the generation of wastewater, which include: – The installation of more efficient drinking water supply systems for animals as an alternative to water troughs. The supply of water during lairage can be controlled according to demand on the part of the animal. In this way, the appropriate amount of water can be supplied at suitable intervals. The amount of drinking water can be optimised with the installation of non-continuous water supply systems that can be operated directly by the animals, or by means of level indicator floats when an established minimum level is reached in water troughs. – Reducing the amount of undigested food by not feeding the animals for between 8 and 24 hours	Lairaging	GHP GHPH	Reduction in water consumption. Reduction in slurry. Reduction of paunch and stomach content. Reduction in the quantity and pollutant load of wastewater.

before slaughter, in order to reduce amounts of manure and slurry produced during lairage.			
Stunning with CO_2 Stunning with CO_2 is more effective than with electric currents, as it improves the percentage of blood collected in the bleeding process by slowing cardiac arrest and lessening stress for the animal.	Stunning	GHP	Increased percentage of blood extracted. Improved quality of meat.
Blood collection Blood is the liquid with the highest COD level of all those present in the meat industry (around 375,000 mg O_2/l), together with a high concentration of nitrogen (30,000 mg/l). The presence of these and other pollutant parameters in blood, together with the high volume of blood generated, means that the incorrect handling of this substance can have significant consequences both when its destination is a treatment plant (on-site or municipal) and when it is discharged directly into the public water supply. One of the most important environmental practices in a slaughterhouse is the containment of blood and its appropriate handling within the facility that can be ensured by optimising bleeding and blood collection techniques.	Bleeding	GHP	Reduction in the pollutant load of wastewater.
Double drainage system in the bleed hall The facility should have systems enabling the collection of all blood in the bleeding area, reducing as far as possible the spillage of blood in other parts of the facility and avoiding blood residues reaching water collection systems. To reduce the risk of accidental discharge of blood in the bleeding area, the facility of a drainage system with two sets of pipes is suggested: one which leads to the blood storage tank and the other which leads to the sewer system. During slaughtering operations, the pipes leading to the blood storage tank are used. In this way, the blood that is collected is not diluted with water and the amount of blood present in wastewater is reduced as far as possible. According to an example given in the BREF, the facility of a double drain system combined with collection trays for blood in the evisceration area, together with a pump to feed the blood collection tank, reduced total COD discharge by 22 % (around 1.25 kg COD per tonne of pig carcass).	Bleeding	GHP R	Reduction in wastewater and the pollutant load thereof. Recovery of by-products.

Optimal bleeding When bleeding takes place using traditional methods most of the blood flows in the first 60 - 90 seconds following the opening of the arteries. However, the bleeding process should generally last longer than this, in order to collect the maximum amount of blood possible. To ensure that this is the case, the first thing that should be done is to establish bleeding times that ensure the collection of the largest possible amount of blood. According to the BREF document, the following blood collection yield can be obtained using traditional bleeding methods, but optimising the times: – For cattle, 16 litres can be collected in one minute, from a total of 18 litres. In this case, the kill speed is quite low and in 2 minutes practically all the blood could be collected, using longer trays. – For pigs, 3.2 litres of blood can be collected in the first 40 seconds and 3.5 litres in one minute, of a potential total of approximately 4 litres. These figures suggest that even in efficient bleeding, along the line some 0.5 litres of blood is lost per pig (5.4 l/tonne of carcass) and 2 litres per cattle unit (6.2 l/tonne of carcass).	Bleeding	GHP	Reduction in the pollutant load of wastewater.
Intermediate blood collection troughs To avoid the problem of having to manage large volumes of blood that may have been contaminated by a small volume that is not suitable for recovery by any method, blood collection systems are proposed that incorporate various intermediate blood collection troughs that are smaller than the storage tank, before pumping the blood to this. The object of this measure is the temporary retention and the perfect identification in the intermediate deposits of the blood corresponding to the same batch of animals, until the veterinary inspection and, where appropriate, the sanitary certification of each batch. Following this, the blood of the checked batch can be transferred to the storage tank, where it will be mixed with the blood of animals from other certified batches.	Bleeding	NT GHPH	Reduction in waste.
Horizontal bleeding Horizontal bleeding avoids the risk of microbiological contamination of the blood due to contact with excrement, urine, gastric juices and dirt in general. As a general rule, this bleeding system follows electrical stunning, as the time in which the animal	Bleeding	GHP GHPH	Reduction in the pollutant load of wastewater. Improvement in meat quality.

remains unconscious is sometimes insufficient to allow the animal to be hung up. The capacity for blood extraction is reduced by a third when horizontal bleeding is used.			
Fill control and protection of blood troughs To avoid overflows from the blood storage deposits during filling due to a lack of control from manual handling, level detectors can be installed in these deposits that can generate an audible alarm before they overflow or can cause input into the deposit to be stopped. The facility of retention ponds with a capacity to retain 110 % of the volume of the liquid contained in the deposit is also considered a prevention measure for the involuntary overflow of blood resulting from cracks in the storage containers.	Bleeding	GHP	Reduction in the pollutant load of wastewater.
Cleaning the animal prior to scalding The animals generally reach the scalding stage with a significant amount of dirt on them: blood sticking to the skin from the previous process, remnants of faeces, urine, bedding, food, etc. In this situation, and when immersion tanks are used, it will be necessary to change the water frequently in order not to affect the hygiene conditions of the product. If a steam scalding tunnel is used, the water can be recirculated fewer times, resulting in increased water consumption. Regardless of the scalding system used, the surface dirt on the animal is a problem from the point of view of water consumption, as the scalding water gets dirty very quickly. An alternative, avoiding the premature dirtying of water and therefore making the most of its heat for longer, consists of cleaning the animals prior to their entry into the scalding stage. In this way, the water in the scalding tank or in the steam scalding tunnels will be less dirty and can be reused for longer, with the resultant water and energy saving.	Scalding	GHP GHPH	Reduction in the pollutant load of wastewater. Improved meat quality. Saving in energy consumption.
Spray scalding Scalding by immersion in a bath of water at a high temperature is significant for the production of a high volume of wastewater with a high organic load, in addition to the consumption of thermal energy for heating the scald water. The replacement of immersion with spray or steam condensation scalding is a solution that involves a change in the existing technology in many facilities and that would to a great extent solve the environmental	Scalding	NT R GHPH	Reduction in wastewater and its pollutant load. Savings in water consumption. Recovery of by-products. Improved hygiene conditions of the carcass.

problems associated with this operation.

- Spray scalding consists of a vertical system in which shower heads spray water heated to over 60 °C on the surface of the animal through nozzles positioned at different heights. The carcass is transported vertically along the transportation rails to a high, closed tunnel, where it is sprayed with hot water. The water is heated with steam in a heat exchanger. The water is recirculated until its hygiene quality no longer permits its reuse in the process, with the subsequent saving in water, energy and wastewater that this implies.

This system, in addition to the environmental improvements with respect to immersion, also reduces the penetration of water into the animal, thus avoiding a potential source of contamination. As a result, the hygiene quality of the carcasses is improved. This method also prevents the risk of over-scalding.

Steam condensation scalding

In steam condensation scalding, carcasses are also suspended vertically and enter a tunnel into which steam is pumped through fans. A cold water system reduces the temperature to 63-64 °C, causing the condensation of the steam, which falls onto the surface of the animals in the form of drops of hot water, which produces the scalding effect.

This process can maintain a constant temperature and 100 % humidity with variable loads, which is crucial for a good scalding operation. The process lasts around 7 minutes and some 3.5 kg of water, in the form of steam, are required for each pig.

This system largely avoids the contamination of carcasses by the scalding water and the entry of water and germs into the lungs through the sticking wound. As in the previous technique, this improves the hygiene quality of the carcass and reduces the risk of over-scalding.

	Scalding tank	Water scalding tunnel	Condensation scalding tunnel
Energy consumption of pumps and fans (kWh/year)	8,400	48,000	35,200
Consumption for scalding (l/year)	90,720	70,632	43,632
Water consumption (m^3/year)	8,440	5,200	336

Scalding

NT
R
GHPH

Reduction in wastewater and its pollutant load.

Saving in water consumption.

Recovery of by-products.

Improved hygiene conditions of the carcass.

1 kWh=3.6 MJ fuel oil 1 kg=1.2 l According to the BREF, water consumption in condensation scalding is 40-65 l/t of carcass and energy consumption is 5.2 kWh/t of carcass. The reduction of water consumption with respect to immersion for spray scalding is 40 %, increasing to 92 % for steam condensation systems.			
Carrying out the first dry cleaning process following de-hairing To reduce water consumption and the generation of wastewater, the dry cleaning and removal of the majority of skins is considered advisable. The animal should then be rinsed.	De-hairing	GHP	Reduction in wastewater. Reduction in water consumption.
Separation of the spinal cord from cattle The following are considered to be Specified Risk Material (SRM): the skull (including the brain and the eyes), the tonsils, the vertebral column (excluding the coccygeal vertebrae and the transverse processes of the lumbar vertebrae, but including the thoracic dorsal root ganglia) and the spinal cord of bovines of over 12 months old. To extract the cord and the listed areas of the vertebral column, the carcass is usually opened and the SRM parts removed. In addition, as a precautionary measure, a margin is removed around these areas in case they have been contaminated by the splitting of the carcass. The amount of SRM removed represents around 30 kg/animal. It is proposed that machines be used that enable the spinal cord to be removed before splitting the carcass, in order to reduce the amount of meat that is extracted with the removal of the spinal column. This practice will enable the amount of SRM produced to be reduced by 50 %. If a slaughterhouse that slaughters 25,000 animals/year invests €23,000 in the purchase of this machine, it can save around €7,000 per year (0.20 €/kg) in the management of SRM material. In addition to this, costs resulting from increased energy consumption and staff training should also be taken into account.	Evisceration	GHP GHPH	Reduction in batch condemnation. Reduction in pollutant load of wastewater.
Transportation of by-products and meat waste The viscera and cuttings generated during evisceration should be transported hygienically manner so that they do not become unusable, thus turning into waste.	Evisceration	GHP GHPH R	Reduction in wastewater and its pollutant load. Elimination of odours.

The replacement of the hydraulic or mechanical transportation of meat by-products or waste within the facility with dry pneumatic systems (that do not use water as a means of transportation) enables generation of a volume of transportation water with a high level of organic contamination (blood, solids, fat, hair), due to the transfer of these materials from the waste to the transportation water, to be avoided. Another advantage is that these dry transportation systems enable by-products to be obtained in better hygiene conditions, as the possibility of microbiological contamination from the transportation water is reduced. The level of moisture in the by-products is also reduced. On the other hand, it should be noted that pneumatic systems use air currents or compressors in closed pipes. These require more complex control systems, require higher levels of maintenance and can be more complicated to clean than hydraulic systems.		NT	
Rinsing carcasses Following evisceration, the carcass is rinsed, in order to reduce water consumption. It is advisable for this rinsing to use a controlled process. If washing is automatic, the installation of mechanisms that allow the water supply to be cut when there are pauses in the line for manufacturing reasons ensure water is saved in the operation, avoiding water being needlessly wasted. In continuous wash lines, presence detectors can be installed. These send a signal to open the electro valves, so that water is applied only when the material to be washed passes in front. On the other hand, if there are spray heads that are inefficient and result in high water consumption, these can be replaced with spray nozzles that produce a lower flow with greater wash effectiveness.	Evisceration	GHP GHPH	Reduction in water consumption. Reduction in wastewater generation.
Emptying of paunch and stomach content The dry emptying of paunches and stomachs is considered important, as is their subsequent rinsing and cleaning, to avoid bad odours being produced. Dry emptying also prevent the generation of wastewater with a high pollutant load.	Waste and by-product management	GHP GP	Reduction in wastewater and its pollutant load. Elimination of odours.
Cleaning and conditioning of small intestines As cleaning and scraping operations for small intestines uses abundant water, it is considered advisable to use recirculation systems for cleaning water.	Cleaning and conditioning of small intestines	GHP NT	Reduction in wastewater. Reduction in water consumption.

Another aspect to be considered in the purchase of new small intestine washing machines is that, according to the type of machine, water consumption can be greater or smaller depending on efficiency.			

5.2. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN POULTRY SLAUGHTERHOUSES

Improvement actions	Processes	OPP	Improvement obtained
Blood collection In the bleeding and slaughter areas, part of the blood falls on the floor and is later removed in the cleaning process, which means that the organic load is incorporated into the wastewater. In order to prevent blood falling on the floor, the installation of channels and retention pools is proposed, in order to collect the blood discharged. The application of this measure in a company producing 3,800 chickens/h meant the reduction by 56,200 kg/year of BOD discharged. In addition, given that the working area remains relatively clean, 80 % of cleaning water was also saved.	Bleeding	GHP	Reduction in wastewater and its pollutant load. Reduction in water consumption.
Transport and storage of meat by-products Facilities can be identified in which water is used to help transport intestines from one area to another. In such cases, it is necessary to adjust the amount of water used precisely, as this is an operation in which a high pollutant load can be brought to the discharge of the slaughterhouse by the dragging and dissolution of fluids and solid materials contained in these by-products. If, moreover, more water than necessary is used, the volume of wastewater will be considerable. The transportation of intestines and other organs from the evisceration area to the area where they are to be processed or stored using a manual cart system or an automatic system using trays and suspended hooks, is considered good practice.	By-product management	GHP	Reduction in wastewater and its pollutant load. Reduction in water consumption.

Reduction in water consumption in the de-feathering line The de-feathering of poultry requires water to lubricate the skin and prevent damage to the carcasses, as a means of transporting the feathers to the storage deposits and to prevent the accumulation of feathers in the machine. By installing water recirculation systems, water consumption can be reduced by 58 %. A reduction in wastewater will also be obtained.	De-feathering	GHP	Reduction in wastewater and its pollutant load. Reduction in water consumption.
Feather separation system As a general rule, de-feathering in slaughterhouses is done mechanically and the feathers are transported using a water circuit to a rotating filter, in which the feathers are separated from the water and are stored with a high moisture level, which makes their storage and later thermal drying more difficult. The installation of presses that collect the damp feathers on exit from the rotating filter is proposed. These will, on the one hand, extract the remaining water that will be discharged to the transportation canal and, on the other, the feathers, with 55 % moisture.	De-feathering	GHP V	Reduction in wastewater and its pollutant load. Recovery of by-products.

5.3. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN SPLITTING HALLS

Improvement actions	Process	OPP	Improvement obtained
Use of meat by-products It is convenient to use meat by-products in the manufacture of other products, wherever this is possible. As an example of a good practice, the use of meat and fat trimmings in the de-boning of hams for the production of fine pastries should be highlighted. To maximise the use of by-products, the following steps are recommended: the separation of all by-products, ensuring that by-products are not contaminated with water or materials that limit their reuse, and storing by-products correctly so that they do not deteriorate.	Splitting	GHP V	Reduction in meat waste.

Adaptation of working surfaces To reduce the capacity for dirt retention on working surfaces, floors and walls and to facilitate the cleaning of these, they should be hygienically designed so that they are easy to clean. In this way, the consumption of water, chemical products and energy are reduced, as is the time spent cleaning them. In addition to this, so that liquids and water do not accumulate on work surfaces and the floor during splitting operations and the cleaning of the facilitiess, it is recommended that both the floors and the work tables be sufficiently sloped to allow the evacuation of liquids.	Splitting	GHP GHPH	Reduction in the pollutant load of wastewater. Improved hygiene conditions. Reduction in resources used in cleaning operations.

5.4. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN THE PRODUCTION OF COOKED AND CURED PRODUCTS

Improvement actions	Process	OPP	Improvement obtained
Reuse of brine In the process of injecting brine into cooked ham, part of the brine does not enter the muscle, dragging out muscle fibres and meat particles that are incorporated into the brine recirculation circuit, saturating it and later blocking the injectors. It is proposed that a rotating filter device be included in the system, in order to eliminate this residue from the brine.	Injection	GHP	Reduction in wastewater and its pollutant load.
Steam cooking This process takes place in cooking chambers that act as cooking ovens, in which the products are subjected to the action of hot, moist air, thus producing the coagulation of the proteins. However, this system has one main limitation: it can only be applied to those products cooked in moulds or artificial skins. Steam cooking systems increase the production capacity and do not generate wastewater.	Cooking	NT	Reduction in wastewater and its pollutant load. Reduction in water consumption.
Continual cooking and cooling system Equipment is used in the meat sector that enables automatic processes to take place of continual maceration, moulding, loading large-capacity cooking vessels, cooking, cooling, unloading of cooked products, de-moulding, subsequent cooling and washing of moulds.	Cooking	NT	Reduction in wastewater and its pollutant load. Reduction in water consumption.

Cooking and cooling take place in the same insulated container through immersion in water at a controlled temperature, which guarantees at all times the quickness and homogeneity of all of the thermal treatments.

The water supplied comes from storage tanks that are kept at a constant temperature. There are usually three containers that supply water at

80 °C for cooking, 15 °C for preliminary cooling and 1 °C for cooling, attaining interior temperatures of the product of 65 °C, 35 °C and 5 °C respectively.

For the cleaning of the water recirculated in the continual cooking system and to lengthen its useful life, the installation of filters, UV rays or ozone treatment is recommended.

The following table shows the technical characteristics of a line producing 100 t/day.

Water consumption for cooking and cooling	4,000 l/day
Electricity consumption	100-200 kW
Steam for keeping the cooking water at 80 °C	1,000-1,500 kg/h
Cold for keeping the preliminary cooling water at 15 °C and the cooling water at 1 °C	400,000-600,000 kcal/h
Compressed air at 6 bars	10 m^3/h
Volume of the storage containers	350 m^3

Cooling of cooked products By using mixed cooling systems for cooked products that use water and cold air, it is possible to reduce water consumption and wastewater generation. The use of air for cooling has the disadvantage that the heat transfer between the air and the product is low and therefore the cooling time can be longer. This contrasts with the need to ensure a rapid reduction in temperature to avoid the growth of micro organisms.	Cooking	GHP NT	Reduction in wastewater and its pollutant load. Reduction in water consumption.
Standardisation of cooling and cleaning times As the cooling and cleaning of cooked products is carried out manually, excessive water may be consumed. For this reason, it is proposed that cooling and cleaning times be standardised, so that a sufficient level of cleanness is obtained, controlling these operations by installing timers.	Cooking	GHP	Reduction in wastewater and its pollutant load. Reduction in water consumption.

Reduction in the pollutant load on emptying cooking pans When the cooking of meat products is finished, pans are emptied into the sewage system, with the consequent discharge of meat remnants and fat. To reduce the organic load of the wastewater, the measure proposed is the separation of organic remains from the cooking liquid by means of extraction through the underside of the pan of the decanted solids and their separate storage after pouring the cooking liquid into the internal drainage network. In this way, the emulsified fat can be recovered manually in order for its subsequent management as meat waste.	Cooking	GHP	Reduction in wastewater and its pollutant load.
Container for the recovery of salt When the salting of parts takes place using the piling of the parts in containers, the used salt can be recovered and reused, mixing it with new salt. The mixture is usually 1/3 recovered salt with 2/3 new salt. To recover the salt, the container is emptied into a vibrating hopper that facilitates the separation of the salt from the ham, storing it in a lower container. The use of this equipment reduces the desalting time of the ham, obtains a higher yield from the salt and reduces saline waste.	Salting	GHP R NT	Reduction in saline waste.
Dry removal of salt prior to the washing of hams Wet washing operations of salted hams generate water with high electrical conductivity. One way of reducing the electrical conductivity of the wash water is to remove as much salt as possible from the surface of the ham when dry. To this end, automatic systems are currently in use for the dry elimination of salt from the surface of the ham that improve the efficiency of salt removal. These systems may be: – Mechanical (application of brushes to the surface of the ham). – Pneumatic (jets of air or vacuum). – Mixed (mechanical brushing combined with vacuuming of the salt). It should be highlighted that it is possible to recover up to 95-98 % of total salt by applying a combined mechanical and pneumatic system, as opposed to a recovery level of 70-80 % with a mechanical system alone.	Salting	GHP GHP H R	Reduction in wastewater and its conductivity. Reduction in water consumption. Reduction in saline waste.

The salt recovered from salting for its reuse should be stored refrigerated in order to avoid the growth of halophilic micro organisms.			
Emptying process of kneaders, cutters and presses Depending on the characteristics of the meat products prepared, on some occasions product remains stick to equipment and utensils. These remains, if not removed prior to cleaning, can generate a high organic load in the resulting wastewater. To reduce the organic load of wastewater generated by cleaning, the physical removal of product remains is proposed, using spatulas. The product obtained can be incorporated into the product if it is collected using a hygienic method.	Prepared meat products	GHP	Reduction in water consumption. Reduction in wastewater and its pollutant load.
Reduction in water consumption in the desalting of small intestines To desalt small intestines, these are usually placed in containers to be washed with a continuous flow of water. One way of reducing desalting water by 85 % is to hang the small intestines in a static bath that is renewed 2 or 3 times per day, which will also result in more uniform desalting.	Prepared meat products	GHP	Reduction in water consumption. Reduction in wastewater.
Pressing of meat products for slicing In the slicing of meat products in skins, waste is generated as the ends of the product are not sold; if the product is pressed into cellulose skins, these should be removed before slicing, as they are hard and indigestible. A good practice for reducing the amount of waste generated in the slicing of these products is to make them in long formats, thus reducing the amount of non-saleable ends, and using reconstituted collagen skins wherever possible, as these do not need to be removed before slicing.	Prepared meat products	NT GHP H	Reduction in waste and improved food quality.
Treatment of meat products produced at high pressure An alternative technology to pasteurisation for the treatment and sterilisation of prepared meat products is the use of high pressures (HP). With pasteurisation, products are exposed to high temperatures in order to destroy pathogenic microorganisms and to prolong their useful life. A	Prepared meat products	NT GHP	Reduction in water consumption and wastewater. Improved quality and preservation of the food. Reduction in water consumption. Reduction in waste

disadvantage of this method, however, is the deterioration of the vitamins, flavour components, flavour and colour of the food. In terms of advantages, HP treatment acts to destroy micro organisms, maintaining the organoleptic properties of the food, in addition to improving its texture and flavour, making it more tender. HP treatment is a non-thermal procedure (there is a minimal increase in temperature to between 10 and 30 °C), that is applied homogeneously and instantaneously, regardless of the size and shape of the product to be treated. The main limitation of HP technology is the resistance to pressure of certain bacterial spores and enzymes. It should therefore be combined with other methods to obtain commercial sterility. Processing at 400 MPa for 2 minutes reduces the bacteria level from 10^6 to 10^3 UFC/g. HP equipment that operates at 400-500 MPa has a useful life of around 100,000 treatment cycles and, although the initial investment is high, the cost of use is not excessive. Three main types of environmental improvements are identified with the use of HP technology: – Reduced water consumption and as a result a lower level of wastewater generation, as the same water is used for each cycle. – Energy saving, as the pressurising of one litre of water at 400 bar consumes the same amount of energy as the heating of the same amount of water to 30 °C, while with this process a higher level of disinfection is achieved. – The amount of packaging used (trays and slice separators) is significantly lower than the amount required for traditional methods.			packaging. Energy savings.
Elimination of small intestine desalting operations It is convenient to use unsalted small intestines as skins for meat products, as this avoids the consumption of large volumes of water for desalting and the generation of wastewater with high conductivity. Artificial intestine for such products is not preserved in salt, although sometimes it cannot be used due to product requirements and client specifications.	Prepared meat products	GHP	Reduction in wastewater and its pollutant load.

5.5. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN THE CLEANING AND DISINFECTION OF FACILITIES, EQUIPMENT AND UTENSILS

Improvement actions	Process	OPP	Improvement obtained
Dry removal of solid waste before cleaning the floor The dry removal by sweeping or using a squeegee of the solids remaining on floors, platforms, tables or equipment (droppings, slurry, meat waste, etc.) is the best way of reducing water consumption and the generation of wastewater from wet cleaning. When the solids have been removed from the surfaces to be cleaned, the amount of water, detergent and disinfectant required will be lower, as will the volume and pollutant load of the wastewater generated. Vacuum suction equipment facilitates the dry removal of solids and has proven to be highly effective, particularly in splitting halls. In order to retain solids prior to the use of cleaning liquid, it is helpful to install filters in the water channelling circuits that will retain solid particles. The waste retained in the filters should be emptied into a container provided for this purpose and the filters should be replaced prior to cleaning with water.	Cleaning and disinfection	GHP	Reduction in wastewater and its pollutant load.
Control of water consumption The management of water consumption can be optimised by the control of environmental indicators, which indicate the consumption and discharge of wastewater with production. These indicators reflect the evolution over time and enable the effects of measures adopted to be observed in economic and environmental terms. This enables areas and aspects to be identified where improvements could be made. The use of indicators allows significant variations to be detected with respect to normal consumption values, such as unnecessary consumption, accidents, leaks or failures in the processes. To obtain the water consumption indicators, it is necessary to know the distribution of water in the different sections of the establishment through the installation of strategically distributed meters. Simply by installing flow meters and taking regular readings, it is estimated that potential savings of between 5 and 10 % can be made.	Cleaning and disinfection	GHP	Reduction in water consumption.

Use of hot water To avoid the excessive and sometimes unnecessary consumption of hot water, it should be used for cleaning only when fats have to be removed, using a maximum temperature of between 40 °C and 50 °C, with the aim of not coagulating the proteins and therefore making cleaning easier.	Cleaning and disinfection	GHP	Energy efficiency.
Minimising water consumption in cleaning In cleaning operations, due in some cases to the excessive separation between taps, operators are obliged to move each time they change cleaning zone. To avoid the unnecessary waste of water, the suggested change is for quick-closing devices to be installed at the ends of cleaning hoses, that only allow water to flow out when the opening lever is pressed.	Cleaning and disinfection	GHP	Reduction in wastewater. Reduction in water consumption.
Optimising cleaning operations of facilitiess and machinery Cleaning operations can be optimised with small investments, such as the incorporation of control mechanisms (nozzles, closing levers for hoses, etc), the modification of machinery or changes in pumps and with major investments, such as the purchase of specific cleaning equipment with which there are generally savings in energy or raw materials.	Cleaning and disinfection	GHP	Reduction in the consumption of detergents and disinfectants. Reduction in water consumption. Reduction in wastewater and its pollutant load.
Advanced utensil cleaning systems The use of automatic cleaning equipment enables reductions to be made in the consumption of water and cleaning and/or disinfection products with respect to traditional methods, as higher pressure can be used and the cleaning solutions can be recirculated. Depending on the quantity and the homogeneity of the utensils to be washed, these systems can be continuous (tunnels for a large number of items of the same size for relatively continuous periods) or batch (automatic cabinetds/booths).	Cleaning and disinfection	GHP	Reduction in oxidizable materials and suspended solids. Reduction in the consumption of detergents and disinfectants. Reduction in water consumption.
Application time of foams and disinfectants The application times of detergents and disinfectants should be followed as defined in the established protocols, in order to ensure effective sanitisation and lower water consumption.	Cleaning and disinfection	BPA	Reduction in the consumption of detergents and disinfectants. Reduction in water consumption.

Adaptation of water pressure To optimise water consumption in cleaning and disinfection processes, a good practice is to adapt the water pressure according to the types of cleaning and the areas to be cleaned. It is considered appropriate to use water at medium pressure (10-60 bar) in clean areas and water at high pressure (> 100 bar) in areas where the formation of clouds due to water spray does not cause cross contamination problems.	Cleaning and disinfection	GHP	Reduction in water consumption.
Dry removal of waste generated As waste increases the pollutant load of wastewater, it is suggested that dry cleaning be carried out wherever possible, in this way removing the largest possible amount of by-products, waste and solid organic waste in general, from tanks, equipment, surfaces and floors, prior to cleaning them with water.	Cleaning and disinfection	GHP	Reduction in water consumption. Reduction in wastewater and its pollutant load.
Establishment of cleaning procedures for facilities To reduce water consumption in cleaning operations, it is recommended that procedures be established based on hygiene and environmental criteria, specifying the duration, cleaning products and their concentration, application times, responsibilities, etc. In order to optimise these procedures, the hygiene effectiveness of cleaning and disinfection should be evaluated. In addition, personnel responsible for these tasks should receive regular training.	Cleaning and disinfection	GHP	Reduction in water consumption. Reduction in wastewater and its pollutant load. Lower consumption of detergents and disinfectants.
Use of detergents and disinfectants The organic load and toxicity of cleaning water generated can be significantly reduced by the use of detergents and disinfectants with a lower organic load, toxicity and greater biodegradability, provided that the required hygiene conditions are met. On the other hand, the consumption of disinfectant can be reduced if effective preliminary cleaning is carried out.	Cleaning and disinfection	GHP	Reduction in the pollutant load of wastewater and the ecotoxicity of the discharge.
Prevention of drips All receptacles and containers that store meat products that could generate leachates, blood, etc. should be airtight to prevent the overflow or dripping of liquid onto the floor.	Cleaning and disinfection	GHP	Reduction in the pollutant load of wastewater.

Using pressure systems for cleaning exterior facilities To improve the efficiency of cleaning of the dirtiest areas of slaughterhouses, including the animal reception area and the transportation vehicles, the use of pressurised water systems (15-30 atm) is proposed. This would increase the potential of the cleaning water to drag dirt with it and would reduce water consumption, generating a lower volume of wastewater. According to an example in the BREF, the consumption of water when this technique is used is 6 l/pig (78 l/t of pig carcass) and 25 l/cattle unit (100 l/t cattle carcass), with consumption with less efficient systems at 10 l/pig and 80 l/cattle unit respectively.	Cleaning and disinfection	GHP	Reduction in water consumption. Reduction in the pollutant load of wastewater.
Installation of hand and apron washing systems The consumption of water and energy (when hot water is used) is reduced significantly in the washing of hands and aprons through the replacement of sinks and hoses with taps operated by the workers themselves through pedals or controlled by presence sensors that activate the tap when they detect the position of the worker.	Cleaning and disinfection	GHP GHPH	Reduction in water consumption. Reduction in wastewater. Reduction in energy consumption.
Reusing refrigeration water The water used in slaughterhouses for refrigeration and boilers can represent 10 % of total consumption. The recirculation of refrigeration water in a closed circuit is therefore proposed. Refrigeration water can also be reused in other operations, provided that it fulfils the water quality requirements for the use to which it is put.	Cleaning and disinfection	GHP	Reduction in water consumption. Reduction in wastewater.
Installation of gratings in the drains of the internal drainage network The entrance of organic and solid waste into the drainage system can be avoided through the installation of gratings with gaps of the appropriate size. These gratings should be cleaned periodically before cleaning with water. In this way, the water content of the solid waste is reduces and the risk of cross contamination is reduced.	Cleaning and disinfection	GHP	Reduction in the pollutant load of wastewater.
Showering animals in lairage The substitution of unplanned and/or manual showering of animals in lairage by timed diffuser	Cleaning and disinfection	GHP	Reduction in water consumption.

systems that are only activated when there are animals in lairage, allows a reduction to be made in water consumption.			Reduction in wastewater.

5.6. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN THE MAINTENANCE OF EQUIPMENT AND FACILITIES

Improvement actions	Process	OPP	Improvement obtained
Transportation line The speed of transportation lines should be adjusted to the minimum bleeding times that ensure the maximum collection of blood in areas equipped for this purpose (in general, between sticking and scalding operations, in the case of pigs, and between the removal of legs and horns, in the case of cattle).	Installation maintenance	GHP	Reduction in wastewater and its pollutant load.
Scalding tank Scalding equipment that is not appropriately insulated and is open can lose a considerable amount of heat. Equipment for immersion scalding should be thermally insulated to avoid the loss of heat through the sides; the upper part should be covered to reduce the loss of heat through the surface of the water and evaporation.	Installation maintenance	GHP	Energy efficiency of equipment. Reduction in emissions. Reduction in odours.
Repair of leaks and defective steam traps By repairing steam leaks as soon as possible and ensuring the correct maintenance of traps, to avoid the loss of steam in unloading, energy consumption can be significantly reduced.	Installation maintenance	GHP	Reduction in energy consumption.
Recovery of steam condensates By recovering steam condensates and using them to feed the boilers, the consumption of water and energy in the installation can be reduced.	Installation maintenance	GHP	Reduction in water consumption. Reduction in energy consumption.
Preventive maintenance The number of faults and stoppages in production processes can be reduced by a preventive maintenance programme. This increases productivity and reduces the consumption of resources. Preventive maintenance programmes should include:	Installation maintenance	GHP	Stoppages in production are avoided.

– An inventory of the equipment in the installation. – Equipment data sheets. – A schedule of maintenance activities. – Maintenance instructions. – A register of maintenance activities, including incidents and breakdowns.			

5.7. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN AUXILIARY PROCESSES

Improvement actions	Process	OPP	Improvement obtained
Optimising the boiler circuit It is advisable for boilers to purge themselves automatically according to conductivity and for the condensate to be recovered, in order to save water and energy. To reduce energy consumption and atmospheric emissions, regular preventive maintenance should be carried out on boilers.	Auxiliary activities	GHP	Energy efficiency of equipment. Stoppages in production are avoided.
Optimising the operation of refrigerators and freezers If the doors of refrigerators and freezers are left open for longer than necessary, the interior temperature increases. This means that more energy is required for chilling, in addition to the consequent risk of heating of the product and breakage of the cold chain. To reduce energy consumption and minimise cold loss, the following options are proposed: – Closure system controlled by a photoelectric cell, so that when the door is opened and a certain number of seconds has passed, if the cell does not detect any presence, the door is closed. – Timed closing system, which allows a specific amount of time to pass when the door is open, following which time the door is closed. – Warning systems that go on when the maximum door opening time has passed (sirens, etc.) – Air curtains. – Plastic slat curtains.	Auxiliary activities	GHP	Energy efficiency of equipment.

Recirculation of defrosting water in the chilling elements of the evaporators Significant savings in the water used for the defrosting of refrigerators can be obtained by the collection, heating and recirculation of the frost water from evaporators and its reuse.	Auxiliary activities	GHP	Reduction in water consumption.
Thermal insulation of knife sterilisers It is estimated that average water consumption in an uninsulated knife steriliser, with water flowing continually, is approximately 2,000 l/day. If the steriliser is insulated and covered, heat loss can be reduced. This means that the frequency of renewal and therefore the volume of hot water is reduced. With the use of insulating material of 20 mm thick, heat loss can be reduced by 80 % in comparison to a steriliser that is uncovered and uninsulated.	Auxiliary activities	GHP GHP H	Reduction in water consumption. Reduction in the risk of cross contamination.

5.8. OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN MANAGEMENT AND ORGANISATION

Improvement actions	Process	OPP	Improvement obtained
Minimising lairage time of animals To reduce the amount of manure and slurry generated in lairage and pens during animal lairage, it is proposed that the time spent there by the animals be reduced through agreements with farmers, depending on the planning of production in the slaughterhouse.	Production	GHP	Reduction in slurry, manure and rubbish.
Improved planning of production As the use of specific production lines for a single product line may be economically unviable, there is a risk of cross contamination from the ingredients of different products that have been produced on the same lines, as the same equipment and utensils are used. To avoid the problems mentioned above, it is recommended that intermediate cleaning of equipment be carried out. In addition, wherever possible, good planning of production should be carried out for minced products produced, so that the number of cleanings necessary is reduced.			Reduction in water consumption. Reduction in wastewater generated and its organic load.
Design and implementation of a programme of Good Housekeeping Practices Through the application of good housekeeping	Environmental management	GHP	Reduction in the consumption of water, energy and materials.

practices, it is possible to improve water, energy and materials consumption, in addition to reducing waste. The following practices are proposed to improve water management: – Repair of water leaks as quickly as possible. – Installation of level probes in water tanks. – Carrying out a routine programme of visual auditing of the management of water and wastewater in the installation. As practices that improve the management of energy consumption, the following are proposed: – Reducing heating / cooling times where possible without harming the product. – Controlling the key parameters in each process such as temperature, pressure, flow, tank fill levels, etc. As practices that improve the management of material consumption, the following are proposed: – Elimination of halogenated substances such as refrigerants, with particular attention to CFCs and HCFCs. – Choice of packing materials with the least possible environmental impact, taking into consideration weight, volume, components and potential for recovery, reuse and recycling. As practices that minimise waste generation, the following are proposed: – Maintaining good control of inventories to avoid the loss or deterioration of raw, secondary and auxiliary materials. – Ensuring that employees are informed of the environmental aspects that the company's operations generate and their personal responsibilities in this respect. – Keeping working areas organised in order to avoid accidents. – Evaluating waste collection systems to check whether they can be improved. – Separating solid waste for its reuse or recycling.	Production		Reduction in the generation of wastewater and its organic load. Reduction in waste generation.
Implementation of environmental management systems The implementation of environmental management systems (EMS) helps companies to manage their	Environmental management	GHP	General improvement of environmental behaviour.

environmental impact through the control of the operations generating it and the commitment to systematic environmental improvement. Indirectly, the implementation of an EMS contributes to improving the quality of the product and to improving the prevention of risks associated with the industry's activities. One of the requirements integrated into the EMS is the regular training and awareness-raising of the company's staff with regard to the related environmental aspects.			
Provision of raw materials in large format containers By using large containers for the provision of raw materials, it is possible to reduce waste packaging produced by the company. If these containers are in addition returnable, there is a further reduction in waste.	Environmental management	GHP	Reduction of waste packaging and containers.
Recovery of by-products with added value In order to recover meat by-products, the recovery and separation of products is recommended, such as pig intestinal mucous, in order to obtain substances of high pharmaceutical value, such as heparin.	Environmental management Production	R	Recovery of by-products.
Acquisition of a condenser-evaporator The evaporation and condensation of brine from the desalting of intestines and hams reduces the conductivity of wastewater and by-products are obtained in the form of distilled water, which can be reused in refrigeration and cleaning processes and salt, which can be reused for the salting of products or for animal feed.	Environmental management	T R	Reduction in the generation of wastewater and its organic load. Reduction in conductivity and suspended solids. Reduction in wastewater treatment costs.
Storage of organic waste The management of by-products in the meat industries are generally based on three basic principles: – Identification and quantification of the main by-products and waste. – Adaptation of the management of all by-products/waste to applicable legislation (environmental and sanitary/hygiene). – Adaptation of separation. As a good practice in waste management, the storage of by-products should be in closed containers and of a short duration. If by-products and/or waste are to leave the installation within a	Environmental management	T V	Recovery of by-products. Reduction in odours.

few hours of collection, they may not require refrigerated storage. Where by-products have to be stored for prolonged periods, they should be kept in specific refrigerated areas in order to preserve them.			
Wastewater treatment According to the characteristics of the wastewater generated (volume and pollutant load), a specific treatment should be chosen for application in order to ensure the water is in a fit state to be discharged into a collector or the public drainage system, as applicable in each case. In general, treatment usually includes a minimum of the following steps: – Aerated homogenisation – Grinding – Screening to 1 mm – Separation of fat (by flotation). Flotation can be attempted without the addition of reactives; where necessary, polyelectrolyte can be added. – Stabilising of the sludge. This can be done by chemical means or biological means. In the second case, the final sludge volume is less.	Environmental management	T	Reduction in the pollutant load of wastewater.
Dehydration of blood Blood can be recovered in the installation itself or can be sold to external managers. When recovery techniques begin in the installation itself, blood can be treated with steam coagulation prior to its transformation into meal, with the brine then treated in the water purifier.	Environmental management	T	Recovery of by-products.
Substitution of fuel oil and propane with natural gas Depending on the type and quality of fuel used in furnaces, the concentration of sulphur gases (SO_x) in combustion gases varies. The best technique for reducing the concentration of SO_x in combustion gases is the use of fuels with a low sulphur content. Natural gas is a fuel that is practically sulphur-free. The substitution of heavy fuels such as fuel oil with other, lighter fuels with a lower sulphur content reduces atmospheric emissions of sulphur oxides and other pollutant gases.	Environmental management	SR M	Reduction in atmospheric MO_x and SO_x emissions. Efficiency of combustion.

Energy recovery If cold facilities have the appropriate heat exchange and recovery elements, heat can be recovered and reused that otherwise would be dissipated into the atmosphere or eliminated along with the discharge of the water from refrigeration.	Environmental management	R	Reduction in energy consumption.
Environmental conditions of the facilities The scalding, cooking and evisceration areas should be well ventilated to avoid cross contamination and the deterioration of electrical equipment due to the generation of damp mists. To avoid bad odours escaping to the exterior, filters should be installed at the air extraction points that retain or eliminate the particles that generate the odour. The points at which unpleasant odours are generated should be insulated and ventilated, adding oxidant agents such as nitrates where necessary to reduce the unpleasant odour of waste.	Environmental management	GHP GHP H	Improved hygiene conditions. Elimination of odours.
Equipment for the extraction of fat from carcasses To extract fat from the carcasses, machines can be used that carry out the extraction automatically. This reduces the risk of cross contamination.	Production	GHP H R	Recovery of by-products.
Treatment and conditioning of process water To improve the quality of process water supplied to facilities, treatments are recommended that save water and involve the lowest possible cost. The most frequent treatments are ion exchange for the decalcification and deionising of the water and inverse osmosis and UV or ozone treatment to eliminate the organic or bacterial load of the water. The control of the regeneration of resins is proposed by the measurement of the hardness, the water flow and the regeneration cycles. It is also proposed that the reject waters be used for the bulking of resins and for the last washes.	Production Auxiliary activities	GHP GHP H	Reduction in water consumption.
Saving water for sanitary use The amount of sanitary water consumed is directly proportional to the number of employees. Measures proposed to reduce water consumption are:	Environmental management	GHP	Reduction in water consumed.

– The reduction in the capacity of WC cisterns. – The installation of water use limiters such as taps with time switches, on/off sensors, etc. – The installation of flow and pressure reducing valves. – Load reducing devices. – Systems for the collection and use of rainwater.			
Separation of wastewater The drainage system can be designed to separate wastewater into different categories, collecting the highest possible quantity of wastewater and treating this waste correctly. The following separation is proposed for the design of new facilities: – Discharge of rainwater and refrigeration water in the same system, as these are not normally contaminated. – Collection of wastewater from lairage and from the cleaning of trucks in a second system, as this wastewater usually contains manure. The material filtered from this system can be used for the production of biogas or for composting. – Separate channelling of the wastewater from production and packaging.	Environmental management	T	Reduction in wastewater. Reduction in treatment costs for wastewater.

PPO: Pollution Prevention Opportunities

6. EXAMPLES OF CASE STUDIES OF OPPORTUNITIES FOR POLLUTION PREVENTION AND REDUCTION AT SOURCE IN THE MEAT PROCESSING INDUSTRY

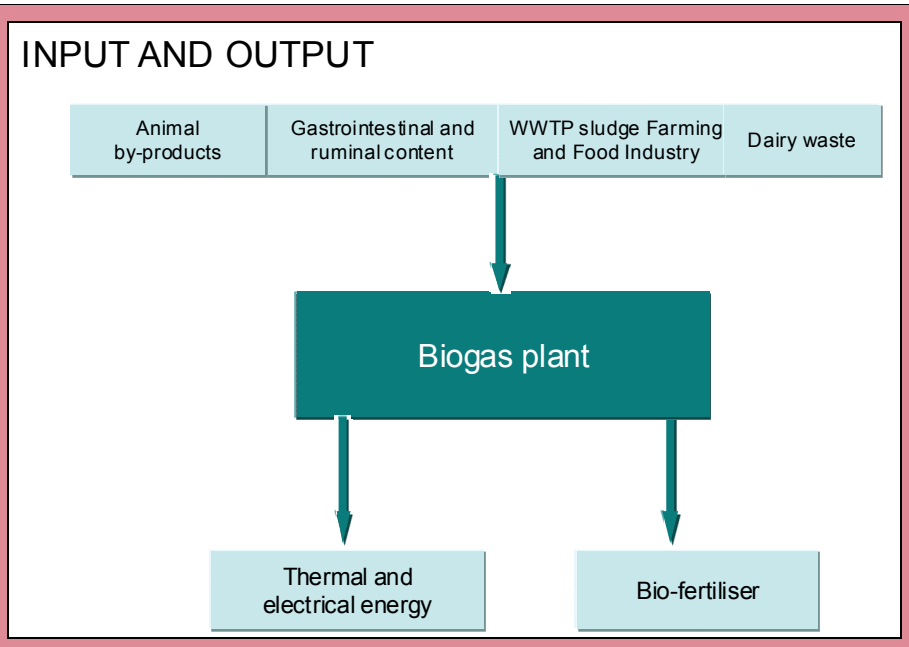
This chapter provides examples of real cases where opportunities for pollution prevention have been applied in the meat industry.

6.1. REDUCTION IN ENERGY CONSUMPTION AND THE GENERATION OF MEAT WASTE BY THE DEVELOPMENT OF A BIOGAS GENERATION PLANT

Company	Matadero Frigorífico del Nalón S.L. (Fries, Langreso, Asturias, Spain). Company engaged in livestock slaughtering and meat preservation.
Industrial Sector	Meat
Environmental Considerations	The waste produced in the meat sector is becoming a growing problem from a technical, financial and environmental point of view. At present, some animal by-products can no longer be converted into meal and reintroduced into the food chain due to the limitations introduced into Community legislation as a result of outbreaks of bovine spongiform encephalopathy (BSE), (Regulation (EC) No. 1774/2002). This problem, together with high electricity consumption due to the energy requirements for the use of machinery and for refrigeration in facilities, led to the development of new technologies for the use of organic waste to generate energy.
Background	Matadero Frigorífico del Nalón developed a project for the transformation of organic waste into high value products by means of their digestion in a biogas plant. The products of this process are biogas and digested biomass. The latter can be used as a bio-fertiliser or can be deposited in a landfill site. In this way the company can cover part of the energy demand of the slaughterhouse. To carry out biogas generation on an industrial level, Matadero Frigorífico del Nalón participated in a European LIFE project, Enerwaste, “Implementation of an anaerobic digestion facility at a Spanish slaughterhouse for a sustainably closed energy and waste cycle”, which was chosen among the five “Best of the Best” of the 24 best LIFE Environmental projects. The LIFE project consisted of developing a pilot plant for the generation of biogas in which to carry out experiments and obtain reliable data, while also acquiring the experience necessary to design a large-scale optimised industrial plant.

	The pilot plant was the first plant built in Spain and also in the EU, with the exception of one plant in Sweden, in which the biogas obtained is used by a transport company.
	
	Total investment was 347,932 euros, of which 84,039 euros were contributed by the LIFE project.
	
	The phases of the project were as follows:
	
	• 2001 – 2002. Viability study of the energy self-sufficiency of a slaughterhouse.
	
	• 2002. Development of a pilot anaerobic digestion plant.
	
	• 2002 – 2003. ENERWASTE LIFE Project.
	
	• 2004 – 2005. Use of the biogas.
	
	  • Purification: desulphuring, reduction of CO_2.
	
	  • Cogeneration engine: electricity, heat and cold.
	
	• 2006. Development of an industrial plant. In the process of IPPC environmental approval.

Summary of the action	Utilizing meat waste The pilot biogas generation plant consists of a series of tanks through which the waste, bovine and porcine fat, the intestines and the intestinal content pass, together with the animal wash water and the plant cleaning water, until the final result is obtained. A first container houses the industrial chopper that reduces the waste to particles of between 10 and 20 mm, which provides the bacteria with a greater surface area and enables a faster digestion process. From there, the waste goes on to the sanitising tank, where it is subject to heat treatment at 70 degrees for an hour. The first container is connected on the inside to another vertical container, which houses the digester. The anaerobic process, the decomposition of the organic material by bacteria with no oxygen, takes place in this container following the addition of the liquid waste. The material first passes through the mashing vat, where the particles are reduced to less than 4 mm and the material is then pumped to the hydrolysis tank, with a retention time of 4 or 5 days. From there, it passes on to an automatic mixer that is placed at the height of the digester and that mixes the input material and ensures the continuous and homogenous feed. Input and output of the biogas production process:



Pilot anaerobic digestion plant:

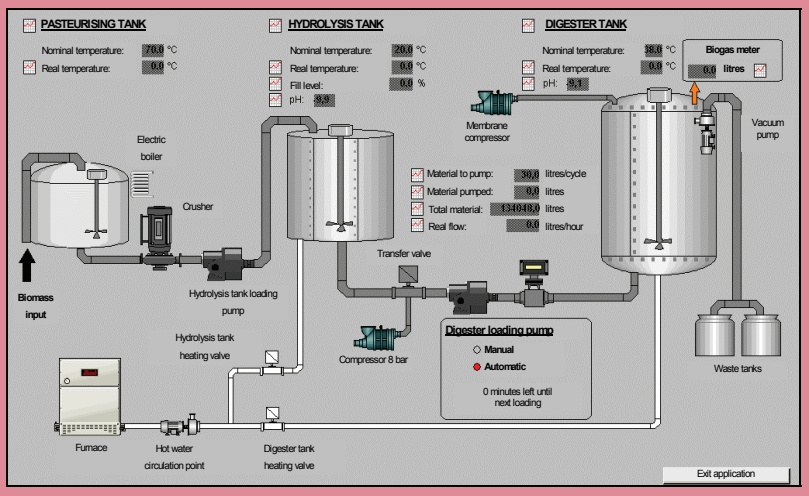


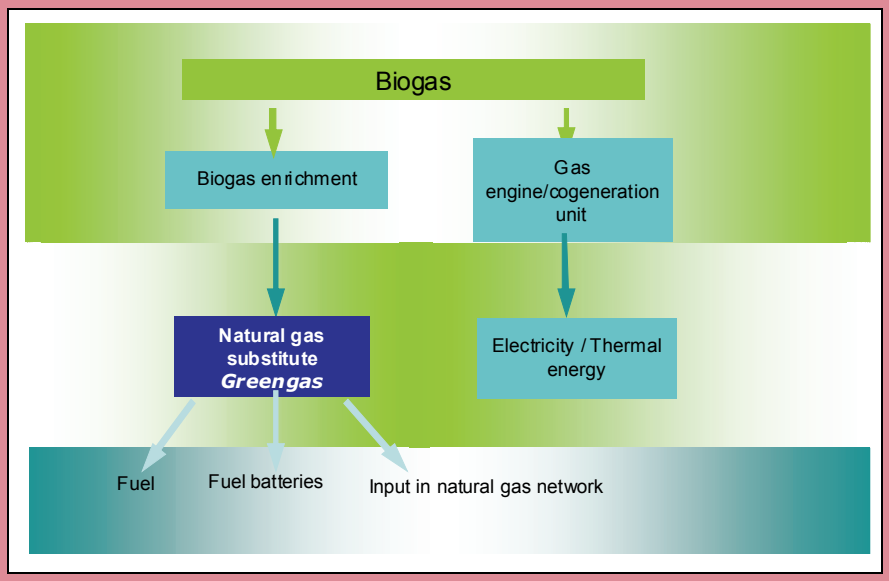
Diagram of the pilot plant

Characteristics of the digester

The plant's digester is 3.5 metres high and has a capacity of 10 cubic metres. Weighing 4.5 tonnes, it is hermetically sealed and is strong enough to withstand the increased pressure inside it.

This continuous anaerobic digestion process lasts for 25 days. During anaerobic digestion, biogas is produced that consists of methane (80 per cent in this case) and carbon dioxide (20 to 50 percent) along with low levels of other gases. A biofilter eliminates the impurities from the gas, which then passes through a liquid. The resulting methane from this process can be used to obtain energy through a cogeneration engine and can be enriched for its use as fuel.

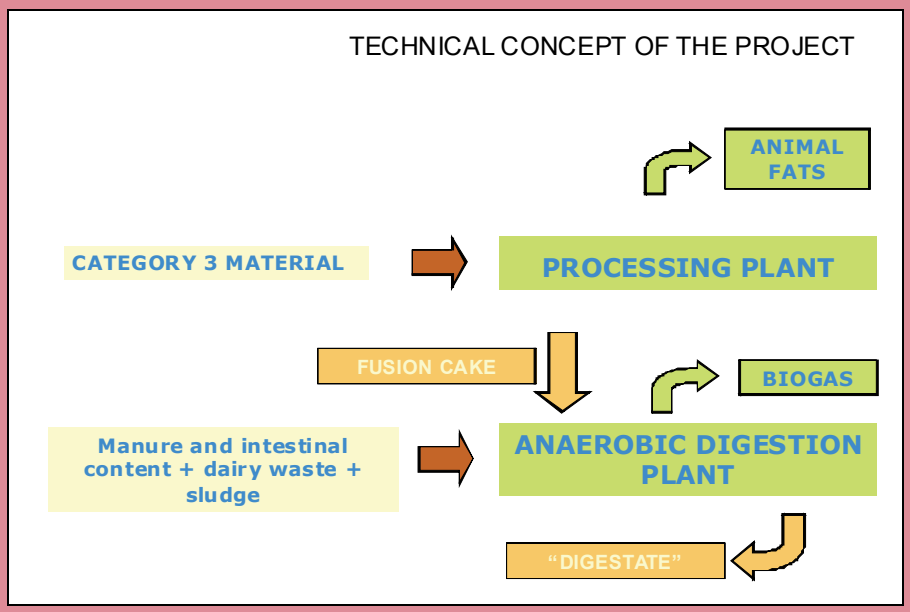
Diagram of use of the biogas generated:



Following this, the digestate can be used as bio-fertiliser.

Characteristics of the digestate

Dry matter	5 %
Organic matter (%/DM)	30 %
Total phosphorous g/l	1
Potassium g/l	1
Total nitrogen g/l	5-8
Ammonium g/l	4-6



Conclusions

Development of an industrial plant

Following the successful results of the project in the pilot plant, the construction of an industrial plant that could treat the waste from 10 meat processing companies is being studied. This plant would have the capacity to treat 9,000 tonnes of waste per year. Production would be of 600,000 m^3N of biogas and 1,970 MWh annually of electricity, of which approximately 10 % would be used by the plant itself.

The main benefits of the project of developing an industrial biogas generation plant are identified as:

- The professionalized management of waste, on a regional basis, linked to the producer:
  - One company responsible for the transformation of the waste.
  - Integrated logistics.
  - Recycling of the waste in the same community.
  - Radius of action:

    10-20 km for liquids.

    >100 km for solids.
- The reduction and control of waste disposal costs.
- Energy generation.
- The use of the digestate as bio-fertiliser.

6.2. REDUCTION OF THE CONTAMINATION AND ORGANIC LOAD OF THE WASTEWATER IN A SLAUGHTERHOUSE THROUGH MODIFICATIONS IN BLOOD COLLECTION OPERATIONS

Company	Carnes Alto Palancia S.L., (Segorbe, Castellón, Spain). The company has facilities that allow the entire meat processing procedure to be carried out: its own slaughterhouse, cutting hall, refrigerated warehouse, processed meat product factory and ham drying facilities.
Industrial Sector	Meat
Environmental Considerations	During the slaughter process in sheep and cattle lines in the company, drops of blood were produced that ended up in the wastewater collector. As blood is the liquid with the highest COD of all those in the meat sector (around 375,000 mg O_2/l), this discharge implied a significant increase in the pollutant load of the wastewater generated in the plant.
Background	With the aim of reducing the pollutant load of the wastewater generated during the slaughter process, a characterisation of this water was carried out, along with a pollution prevention study and a study of treatment with or without minimisation measures.
Summary of the action	Initial characterisation of the wastewater Integrated and spot characterisations were made of the factory's discharge over one day with blood collection and another day without the preliminary collection of blood during the slaughter process, analysing the pH, conductivity, sedimentable material, suspended solids, COD, BOG_5, NKT, ammonia, N-nitric and protein. Collection of blood on the slaughter lines In order to evaluate the environmental impact caused by blood on its addition to wastewater and to analyse the means of minimising the pollutant load, channels and vats were installed to avoid blood dripping onto the floor on the slaughter lines. Physicochemical treatment of wastewater By carrying out flocculation and coagulation tests for wastewater with the prior collection of blood on the slaughter line, it was possible to reduce the organic pollutant load significantly with respect to the results obtained without the collection of blood. By collecting blood, a reduction was obtained in COD of 1000 mg of O_2/l and of 900 mg of O_2/ l in the BOD_5 of the final discharge.

*Sample on the left: final discharge of wastewater without preventing the dripping of blood from slaughter onto the floor.

*Sample on the right: final discharge of wastewater with the collection in channels and vats of the blood generated during slaughter.

Measures to prevent the wastewater contamination

The collection of blood along the slaughter lines was key to ensuring that a simple final pre-treatment of the discharge, consisting of grinding, final sieving, and aerated homogenisation were sufficient to adapt the discharge to the limits of application.

Final discharge treatment installation: Double pump (1+1), final sieving and aerated homogenisation

Conclusions	By preventing the dripping of blood onto the floor, preventing its addition to the wastewater collector during the slaughter process, the organic load of wastewater is significantly reduced, which, together with simple pre-treatment, enables the wastewater to be adapted to the established discharge limits.

6.3. MODIFICATIONS IN THE SLAUGHTERHOUSE PROCESS AND THE APPLICATION OF GOOD HOUSEKEEPING PRACTICES FOR THE REDUCTION OF BIOLOGICAL OXYGEN DEMAND (BOD)

Company	Thad Mermer. Bosnia and Herzegovina.
Industrial Sector	Meat
Environmental Considerations	The main environmental problems associated with the meat processing industry are the high levels of water consumption and the discharge of effluent with high loads of pollutant agents that mainly contain: blood, fat, undigested stomach contents, meat residue and extracts, dirt and cleaning agents. The plant's wastewater was discharged into the Bosna river, after going through a septic tank system that did not treat effluent satisfactorily manner.
Background	To improve the process, actions focused on eliminating the organic pollution from wastewater and reducing water consumption were carried out.
Summary of actions	New technologies were not applied as part of the actions carried out; in fact, operating practices were simply modified. New practices included: increasing bleeding time, constructing a system for the collection of blood and the introduction of controlled composting of manure, instead of dumping it in the river. In addition to this, livestock was no longer fed before slaughter, in order to reduce the amount of undigested food, low-consumption nozzles were attached to water hoses and gratings were installed in drains to prevent solid substances from entering the effluent.
Conclusions	As a result of changes made to the operating practices in the plant, the following improvements were obtained: • Water consumption: 274 m^3/year, a reduction of 15 %. • Salt consumption: 1.8 tonnes/year, a reduction of 60 %. • Biological Oxygen Demand (BOD): 1468 mg O_2/l, a reduction of 42 %.

Source: *SANET Sustainable Alternatives Network.*

6.4. OPTIMISATION OF THE CONSUMPTION OF PROCESS WATER, REDUCTION OF THE ORGANIC LOAD OF WASTEWATER DISCHARGE AND RECOVERY OF ORGANIC WASTE

Company	United Company "Rosty" Kalubia. Egypt. The company was founded in 1998 and has poultry processing lines organised into a slaughterhouse area and a manufacturing unit. Annual production is around 6,600 tonnes. The company employs some 360 workers.
Industrial Sector	Meat. Chicken processing.
Environmental Considerations	The factory's main environmental problems were the organic load of discharge and the management of organic waste resulting from the production processes.
Background	To improve the process, actions were put into practice that focused on eliminating the organic contamination of wastewater and on the recovery of organic waste generated.
Summary of actions	To minimise the volume of wastewater discharge, actions were first carried out to optimise water consumption in the production processes, reaching a total water consumption for the production of 24,000 chickens/day of 120,000 litres/day (5 litres of water/chicken processed). Parallel to this, the organic load of discharge was reduced by the development of a wastewater treatment plant using chemical and biological treatments, enabling discharge parameters within the established limits to be obtained. For the recovery of organic waste generated in the plant, processes were developed for the collection of blood, feathers and meat residue from the different areas of manufacturing, and processes were designed and put into practice for the digestion, heating and pressurising of this waste, obtaining a final product of meal for animal feed.
Conclusions	By optimising water consumption for the process and through the treatment of wastewater through purification of the discharge, parameters for this discharge were obtained that are within the established limits. In turn, the transformation of organic waste into meal for animal feed minimises the need to manage this waste externally and instead the waste is managed as a by-product.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. CONCLUSIONS

In terms of the global situation of the meat sector in the Mediterranean Action Plan (MAP) countries, the main conclusions will be presented within the framework of the following sections:

Meat production

The production of meat in the MAP countries with respect to worldwide production has dropped, due to an increase in global meat production. There are major differences in the amounts of meat produced in the countries in question. Over 84 % of the total amount of meat produced in the Mediterranean basin is produced France, Spain, Italy, Egypt and Turkey.

In the countries of the Mediterranean basin, pork is meat most produced, with 32.7 % of the total, followed by chicken, with 27 %, bovine at 22.5 %, ovine and caprine at 7 % and turkey at 5 %. Consumption varies greatly, depending mainly on the population, the amount produced and consumption habits. It should be highlighted that the main producers are also the main consumers.

In the majority of MAP countries, production is lower than consumption, and therefore imports are required. With regard to their balance of trade, only four countries (France, Spain, Tunisia and Slovenia) have a positive balance. The remaining countries import more meat than they export.

Production processes in the meat industry

Three main types of activity are distinguished within the meat industry: slaughter in slaughterhouses, cutting and portioning in cutting halls, and the production of meat products in manufacturing plants.

In the European countries, the meat industries generally have industrial slaughterhouses with high production levels and with cutting halls and, in some cases, the manufacture of prepared products, while the North African countries onthe southern shores of the Mediterranean and the countries of the Middle East tend to have smaller industries, mainly consisting solely of slaughterhouses, with lower levels of production and more traditional, manual methods, with the main destination of these meat products their consumption as fresh products. In these countries, prepared products (cooked or cured products) are mainly imported from other countries and it is a requirement of these imports that they are certified kosher or halal.

As hygiene is a necessity during all of the stages of the production process, as it has a direct influence on the quality and healthiness of the foods prepared, cleaning and disinfection of equipment and facilities is an extremely important auxiliary operation that has a strong influence on the production process and that uses technology and methodologies that are adapted to the sector.

Environmental aspects and problems

The main environmental aspects and impacts generated in the meat sector are those related to wastewater, waste, atmospheric emissions, noise, energy consumption and water consumption; slaughterhouses are the subsector of the activity that have the greatest environmental effects.

It has been noted in a study[4] that the Mediterranean region requires stricter legal measures to combat the environmental challenges and comply with current legislation.

It should be pointed out that in certain MAP countries. There is no treatment for wastewater, due to which, the environmental impact (COD, BOD, SS, and phosphates, nitrogen, and salts in wastewater) for meat producing installations may be very high owing to the discharge of organic material, slurry, manure, and detergents/disinfectants.

Opportunities for pollution prevention and reduction at source

The main opportunities for pollution prevention at source in the meat sector are based on:

- A reduction in water consumption in the production processes and in cleaning and disinfection operations.
- A reduction in energy consumption.
- A reduction in the pollutant load of wastewater.
- The separation of waste streams to facilitate their later reuse.
- The optimisation of wastewater treatment processes.
- The recovery of by-products and waste.

Opportunities for reduction can be obtained through specific actions on the part of the company:

- Process modification.
- The incorporation of new technologies.
- The substitution of raw materials.
- The implementation of good housekeeping practices.
- The implementation of good hygiene practices.
- The recovery of by-products.
- Waste treatment.

It should be highlighted that in the meat industry, the design of facilities and equipment for operating and auxiliary processes has been highlighted as one of the key elements for environmental pollution prevention at source, as it is in the design phase that the separation, treatment and management of wastewater and solid waste must be taken into account, together with the selection of more environmentally sound technology and equipment.

As outlined in the chapter on opportunities for pollution prevention at source (Chapter 5), a large number of alternatives exist that are technically and economically viable, which means that it is possible for the majority of companies in the sector to adopt some of them. The implementation of environmentally sound processes results on the reduction in the environmental impact of the process with lower levels of pollution, together with an additional economic saving.

In this sense, it should be mentioned that the systematic implementation of strategies for pollution prevention at source for meat industry processes and products increases their efficiency and reduces environmental risk.

[4] EEA Report No 4/2006 Priority issues in the Mediterranean environment (revised version). Published by: EEA (European Environment Agency) Office for Official Publications of the European Communities)

7.2. RECOMMENDATIONS

Along with compliance with the environmental requirements applicable to the sector, companies in the meat industry can take a large number of actions aimed at pollution prevention. For the development and implementation of these prevention actions, it would be useful, given the heterogeneity of the companies within the MAP, to carry out the measures outlined in this manual, selecting from among them those that are most appropriate according to their level of management and grade of environmental impact.

To foster environmental management and pollution prevention in the countries and industries of the MAP, the development and implementation of strategic environmental plans in the meat sector, consisting of specific action plans for each country, would be effective. In order to develop these plans, the level of development and compliance with environmental legislation and standards should be harmonised, as for some countries this legislation is incomplete and in some cases practically non-existent.

In order to guide companies in the meat industry in the selection and application of pollution prevention actions, it is considered to be effective to develop indicators including as an example, guidance values for effluent in meat processing facilities (pH, BOD, COD, total suspended solids, etc.).

For the effective application of pollution prevention techniques, the corresponding authorities should provide economic and financial instruments that act as incentives to companies in the sector who make investments in implementing new processes, purchasing new equipment and in general for all those economically viable projects leading to environmental improvements.

On the other hand, the adoption of environmental awareness-raising measures for those companies that have not yet put prevention measures into place is also considered fundamental. It would therefore be recommendable to carry out demonstration projects in which improvement actions and exchanges of experience between participating companies in the sector could be carried out.

Finally, it should be noted that it would be helpful to improve the links between the different companies, organisations of meat producers and institutions involved in the MAP countries, in order to ensure cooperation aimed at the promotion of actions of pollution prevention at source.

8. ANNEXES

8.1. GLOSSARY

Abbreviations

AICE	Asociación de Industrias de la Carne de España
ANSI	American National Standards Institute
APHA	American Public Health Association
ASOCARNE	Asociación Española de Empresas de la Carne
ASTM	American Society for Testing and Materials
ATP	Adenosintrifosfato
AWWA	American Water Works Association
BAT	Best Available Technique
BAT	Best available technology
BOD	Biochemical Oxygen Demand
BOD5	Average Biochemical Oxygen Demand after 5 days of incubation
BREF	BAT reference document
CCAA	Autonomous Communities
CEN	European Committee for Standardization
CFA	Continuous flow analysis
CFC	Chlorofluorocarbon
CIAA	Confederation of the Food and Drink Industries of the EU
CIP	Cleaning in place
Cl-	Chlorides
CNR-IRSA	Consiglio Nazionale delle Ricerche - Istituto di Ricerca sulle Acque
COD	Chemical Oxygen Demand
CONFECARNE	Confederación de Organizaciones Empresariales del Sector Cárnico de España
CTM	Conditional test method
Danish EPA	Danish Environmental Protection Agency
DFD	Dark, firm and dry
DIN	Deutsche Industrie Norm
DM	Dry matter
DO	Designation of Origin
EC	Electrical Conductivity
(EC)	European Community. Acronym accompanying all legislative texts passed in the European Union (Directives, Regulations and Decisions)
ELV	Emissions Limit Value
EMS	Environmental Management System
EN	European Norm
EN	European Standard
EPA	United States Environmental Protection Agency

EPER	European Pollutant Emission Register
EWL	European Waste List
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO on-line database of statistics
FIA	Flow injection analysis
FIAB	Federación Española de Industrias de la Alimentación y Bebidas
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
ICEX	Instituto Español de Comercio Exterior
IEA	Integrated Environmental Authorisation
IEC	International Electrotechnical Commission
IPPC	Integrated Pollution Prevention and Control
IPTS	Institute for Prospective Technological Studies
IR	Infrared
ISO	International Standard Organization
LSC	Low Sulphur Content
MAPA	Ministerio de Agricultura, Pesca y Alimentación
MIMAM	Ministerio de Medio Ambiente
MISACO	Ministerio de Sanidad y Consumo
NH4-	Ammoniacal nitrogen
NIOSH	National Institute for Occupational Safety and Health
O&F	Oils & Fats
OCA	Organismo de control autorizado
ODP	Ozone depletion potential
P	Pressure
PGI	Protected Geographical Indication
PM-10	Particulate matter of under 10 microns in diameter
PNE	Présentation des normes européennes
PrEN	Draft European Standard
SRM	Specified Risk Material
SS	Suspended Solids
T	Temperature
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TSG	Traditional Speciality Guaranteed
TU	Toxicity Units
TWG	Technical working groups
UNE	A Spanish standard
UNEP	United Nations Environment Programme
UV-VIS	Visible ultraviolet
WEF	Water Environment Federation
WWTP	Wastewater Treatment Plant

Elements and chemical compounds

CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
Cu	Copper
EDTA	Ethylenediaminetetraacetic acid
EVA	Ethylene vinyl acetate
KNO_3	Potassium nitrate
LAS	Linear alkylbenzene sulfonate
N	Nitrogen
N_2	Molecular nitrogen
Na NO_2	Sodium nitrite
NaCl	Sodium chloride
NEDA	Naphthalene diamine
NH_3	Ammonia
NH_4^+	Ammonium ion
NO	Nitrogen monoxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of nitrogen ($NO+NO_2$)
NPE	Nonyl Phenol Ethoxylate
O_2	Molecular oxygen
P	Phosphorus
PE	Polyethylene
PP	Polypropylene
R22	Refrigerant from the HCFC family
R404	Refrigerant resulting from the mixture of several HFC
SO_2	Sulphur dioxide
SO_x	Sulphur oxides (SO_2+SO_3)
Zn	Zinc

Measurement units and symbols

atm	atmosphere (1 atm=1.013 bar) (1 atm=101.3 kPa)
bar	bar (1 bar= 0.986 atm) (1 bar=100 kPa)
°C	degrees Celsius
cm	centimetre
g	gram
GJ	gigajoule
h	hour
kg	kilogram
kJ	kilojoule (1 kJ=0.28x10-3 kWh) (1 kJ=0.238 kcal)
kPa	kilopascal (1,000 kPa=9.86 atm) (1,000 kPa=10 bar)
kWh	kilowatt hour (1 kWh=3,600 kJ) (1 kWh=859.84 kcal)
l	litre
m	metre
m^2	square metre
m^3	cubic metre

m^3N	normal cubic metres. "N" indicates that the concentration of a specific substance in the air has been expressed at "normal" pressure and temperature conditions. These conditions are T= 0 °C and P= 1 atm.
mg	milligram
mm	millimetre
MWh	megawatt hour
Pa	Pascal
ppm	parts per million
s	second
t	tonne
V	volt
µS	microSiemen
€	euro

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8.3. ENVIRONMENTAL LEGISLATION IN THE EUROPEAN UNION

Legislation concerning water.

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Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.

Council Directive 83/513/EEC of 26 September on limit values and quality objectives for cadmium discharges.

Council Directive 84/491/EEC of 9 October on limit values and quality objectives for discharges of hexachlorocyclohexane.

Council Directive 84/156/EEC. Of 8 March on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry.

Council Resolution of 7 February 1983 concerning the combating of water pollution.

Council Directive 80/68/EEC of 17 December on the protection of groundwater against pollution caused by certain dangerous substances.

Council Directive 79/869/EEC of 9 October concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water in the Member States.

Council Directive 78/659/EEC of 18 July on the quality of fresh waters needing protection or improvement in order to support fish life.

Council Directive 76/464/EEC of 4 May on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.

Directive 2006/11/EC of the European Parliament and of the Council of 15 February 2006 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.

Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water.

Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC.

Council Directive 75/440/EEC of 16 June concerning the quality required of surface water intended for the abstraction of drinking water in the Member States.

Legislation concerning waste.

Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste.

Commission Decision 2001/118/EC of 16 January 2001 amending Decision 200/532/EC as regards the list of wastes.

2001/119/EC: Commission Decision of 22 January 2001 amending Decision 2000/532/EC replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste.

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Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption.

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Commission Regulation (EC) No 416/2005 of 11 March 2005 amending Annex XI to Regulation (EC) No 1774/2002 of the European Parliament and of the Council, as regards the importation from Japan of certain animal by-products intended for technical purposes.

Commission Regulation (EC) No 93/2005 of 19 January 2005 amending Regulation (EC) No 1774/2002 of the European Parliament and of the Council as regards processing of animal by-products of fish origin and commercial documents for the transportation of animal by-products.

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Legislation concerning food hygiene.

Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs.

Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules on the hygiene of food of animal origin.

Regulation (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption.

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