



Business Case: the benefits of a carcass over a live animal trade

HUMAN BEHAVIOUR CHANGE FOR LIFE

Contributors

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Disclaimer

This study exclusively focused on the export of meat and live animals intended for slaughter to obtain meat in a reasonable time interval (immediately, after a quarantine period, or after a fattening period). Neither the non-commercial transportation nor the breeding animal trade was studied for this report. The model developed for this study centres on the case study from Portugal to Israel.

For further information or enquiries regarding the content of this report, please contact Jo White at and visit www.hbcforlife.org for further information.

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1. Introduction

This report considers the business case for a change to the export of carcass meat instead of live animals from the EU (European Union) to third countries. It includes the current economic, environmental, and societal challenges and opportunities that these different approaches present. This groundbreaking research provides a unique insight into the costs of the trade through the development and use of innovative modelling, frameworks, case studies and evidence-based approaches. It enables the consideration of how a move from live animal export towards a meat and carcass trade could be advantageous for the agricultural sector, the environment and thus, wider society.

It is intended that the findings of this report are utilised by the farming and wider agricultural sectors to aid consideration and shine a light on the current costs, together with the potential benefits of change. In addition, this work can aid the European Union (EU) with developing and implementing future evidence-based policy by closing the current gap in information in this area. This research will also provide those working to improve the welfare of animals and the environment with a broader and more informed view of the current situation. Finally, the findings of this report have the potential to improve the lives of many stakeholders, including farmers, consumers, wider society, and the animals involved in the trade.

1.1. Context and background

As the Organisation for Economic Co-operation and Development (OECD)/Food and Agriculture Organisation for the United Nations (FAO) states (2021), the determinants of meat consumption are complex and subject to change over time, but population growth is a reality that directly increases the overall food needs of the human population. Among other sources of calories and proteins, meat is typically more expensive, thus economic growth is an important driver of its consumption (FAO 2003). As proven by several sources of official statistics and research (e.g., FAO 2003, OECD/FAO 2021, Whitton et al. 2021, OECD 2023), in many emerging market economy countries meat consumption per capita rises in direct correlation with the Gross Domestic Product (GDP) per capita. In higher income countries, no such relationship exists (Whitton et al. 2021) and here the meat consumption per capita may be limited by other factors, such as environmental, ethical, animal welfare, and health concerns (OECD/FAO 2021). Traditions and religious views also play a role, refining the human population's food consumption preferences even more. However, sustainability and inclusiveness are stressed in all domains of social development more than ever because of the exacerbation of the challenge to obtain it, in the context of this unprecedentedly rapid population increase (United Nations 2022). With the development of science and technology in the past 50 years, both the production of food and its international transportation has become much easier and faster, but we also face side effects impacting the global environment. Pollution (including greenhouse gas and fossil fuel consumption generated emissions and the worsening problem of waste disposal), and the worldwide spreading of diseases are among the most concerning of these.

Although the commercial transport of live animals began a long time ago (e.g., according to Low 2008, exporting livestock from New Zealand by ship dates back to the 1860s), the past 60 years have shown an enormous increase in this trade (Urbanski 2021). Meat demand, modern globalisation, the development of the supply chain and transportation means, the liberalisation of animal health restrictions, are all factors of influence (Noriega and de la Lama 2020). Regarding the single market of the European Union

(EU), the operators of live animal trade aim to reduce their costs, maximise revenues, and optimise economies of scale by exploiting cost differences between the Member States (European Court of Auditors Press release 2023b). Moreover, the national differences in the enforcement of the EU animal transport regulation and the different national sanction systems allow transporters to exploit these loopholes in a possibly detrimental way for the transported animals (European Court of Auditors 2023a), such as choosing longer routes to avoid the member countries with more stringent regulations. Under the umbrella of Europe's administrative, legal, and commercial union, authorising transport vehicles, especially livestock vessels, in the member countries with lower standards and regulations (e.g., Romania, visible in the list of authorised livestock cargos compiled by de Bois 2021) is another cost-efficient practice for operators that can lead to worse conditions for the animals during the journey. In the opinion of the European Court of Auditors *"These factors incentivize the transport of animals, particularly when transport costs account for a small fraction of the retail meat price"* (European Court of Auditors 2023b), whether the live animal trade is deployed within the EU or to non-EU countries (European Court of Auditors 2023a). In the light of the upcoming revision of EU legislation, the opportunities identified by the European Court of Auditors (2023b) are:

- promoting the transport of meat rather than live animals, and the use of local and mobile slaughterhouses;
- increasing transparency and harmonisation in meat labelling, for example through an EU animal welfare labelling system;
- providing the right incentives to producers, users, and consumers to encourage sustainable behaviour;
- developing a methodology to account for animal suffering, so it is included in the budget planning regarding transport costs and the meat price;
- harnessing the potential of information technology and technological improvements to track all animal journeys, including, domestic journeys; using cameras and sensors to measure and monitor animal welfare during transport; and using digital tools to optimise the planning and logistics of animal transport.

All these points show that the existing practices used in commercial animal transportation are not sustainable and need to be changed - not only on a legislative, animal welfare and environmental basis but also in relation to the expenditure of the meat consumers in the destination countries.

The suggestion to replace live animal transportation with the trade of meat and carcasses is not new. For example, the European Parliament called for this change, which has been echoed by expert organisations such as the Federation of Veterinarians of Europe (FVE), the World Animal Health Organisation (WOAH, formerly OIE), and the European Food Safety Authority (EFSA) (Porta 2019). Similarly, consistent efforts were made in time to enhance the implementation of the European animal transport law (the Council Regulation (EC) No 1/2005) with plenty of evidence-based documents (such as those reviewed by Bachelard 2022) describing challenges and limitations. The need to improve the legislation itself also became evident. The Joint Position Paper (2022) of five European governments (Belgium, Denmark, Germany, the Netherlands, and Sweden) calls for punctual changes to correct "vague provisions", and the journeys with destinations outside of the EU are included among the major requirements needing to be addressed.

Within the European Commission's public consultation (October 2021-January 2022) to evaluate the EU animal welfare rules, the vast majority of respondents (94% - 55,564 out of 59,281) considered that the export of live animals to non-EU countries for slaughter should be prohibited, with one third (32% - 211 out of 660) of the business organisations supporting the same choice (Ares Cross Portal 2022).

Against this background, a response from the industry came at the beginning of this year (17 January 2023), when the Portuguese delegation submitted a note (5346/23) on the revision of the animal transport legislation to the Council of the European Union on behalf of the French, Greek, Irish, Latvian, Lithuanian, Portuguese, Romanian and Spanish delegations, for a discussion to be raised at the "Agriculture and Fisheries" meeting of the Council. The note states that *"Animal transport is a critical activity in animal production systems in Europe and worldwide, necessary for the smooth functioning of the animal production sectors"*, stressing that *"the primary objective of the revision of the legislation should be the continued facilitation of high welfare intracommunity trade and export of live animals, but not be focused on measures aimed at prohibiting or limiting certain types of transport."* To sustain this request, the delegates explain the risk of third countries being *"obliged to source animals from likely more distant non-EU suppliers with less developed animal welfare provisions"* if the transport of live animals is not facilitated by the EU.

The economic implications of the live animal trade are proven especially as regards the industrial meat and dairy corporations, which attract both private and public investors, reduce competition by buying up smaller companies (or indirectly producing their insolvency), get support from public institutions, and directly drive climate change (the 35 largest meat and dairy corporations emit more greenhouse gases than the whole economy of Germany) according to a 2020 research (Heinrich-Böll-Stiftung 2021). Yet, comprehensive economic studies to explore the costs of meat industry (live animals and carcasses) are scarce. According to a 2022 article of Farm Animal Investment Risk and Return (FAIRR, a collaborative investor network that raises awareness of the environmental, social, and governance risks and opportunities in the global food sector), live animal shipping has only a thin profit margin. The article cites the managing director (Roger Fletcher) of a live animal export company (Fletcher International Exports) stating that *"the trade could only exist 'because it was heavily subsidised by their governments'"* and even then, it is *"reliant upon old fleets and poor welfare standards to keep it commercially viable"*. Although there are a few studies exploring the production costs of farmed animals (such as Raineri et al. 2015 for lambs, Haxsen 2008 for pigs and Deblitz 2012 for cattle), these do not follow the thread of costs and profits further, towards the consumer, in the meat industry chain. As per our knowledge, only a couple of publications present an economic assessment of the production stages from the farms' gate toward the consumers' plate (Baltussen et al. 2009, Baltussen et al. 2017), aiming to compare the costs of live animal transport with that of meat.

Current areas identified for consideration regarding this research project are:

- The EU Commission is currently preparing to change the animal transport legislation. The measures included are meant to ensure good conditions for the animals during the journeys (welfare) and prevention of the spread of disease (biosecurity). Some of the measures included have economic implications as well (strict identification and records of the transported animals, for example, allows both sanitary-veterinary traceability and economic verification).
 - The European Commission has commissioned research and audits:

- To verify the efficiency of the existing legislation, especially with regards to animal protection, and identified gaps. Some gaps are inherent: for example, subsequent research has shown that the measures do not provide enough protection (e.g., stocking density in sheep transportation, journey length, in-field realities such as negative aspects of unloading animals for rest/journey break). Other gaps became evident due to ongoing research undertaken since the law came into force (2005), particularly in relation to animal behaviour and welfare needs (e.g., sheep express a preference to have space and not to be tightly packed together to more easily keep their balance while being moved), and because of rapid environmental changes in the past 20 years or so global warming increasing the risk of heat stress during transportation, especially from colder climates to hotter ones).
- To identify the degree of implementation and enforcement of the existing law in the Member States, in which it found several differences due to national regulations. Where there is one single market, this increases the risk of loopholes being exploited by stakeholders (such as opening operations or authorising transport vehicles in countries with less stringent regulations or, avoiding the countries with stricter national rules by taking alternate transport routes, even if this increases the journeys' length and duration).
- Acknowledges the impossibility of legally verifying the condition of the transported animals once they leave the EU and the impossibility of enforcing the European animal transport law outside the Union.
 - The EU is interested in extending the application of the transport legislation so that it covers the entire journey from origin to destination.
 - Recognises only economic leverage measures (to price in animal suffering, for example) or to stop live animal transport in certain conditions (hot periods of the year, to certain countries, as a ban for certain transporters with repeated illegal practices, etc.).
- Ascertains that the main driver of live animal transportation is economic and that the stakeholders exploit the cost differences between the member countries, or between European and third countries. These are legal practices, but do not fit completely into the European one-market concept.
- The national European authorities monitor the animal transport conditions within each country and the fulfilment of EU-adopted national legal conditions. European audit results and/or situation reports have been published about several Member States. Most describe the welfare conditions of the transported animals; the economic aspects are not detailed.
- The animal welfare and protection organisations performed both EU-commissioned and independent research, verifications, and monitorisation, examining the conditions in which the animals are transported, together with implementation and respect for the animal transport law. Most of the published findings present the welfare conditions of transported animals without detailing the economic aspect of the trade.
- The industry

- Information from different companies who have developed their own internal standards, including advertising their services, demonstrating compliance with the EU laws and care for good animal welfare practices during transportation. They promote transparency, which can be perceived as understanding and approval of the existing rules or building a good commercial image to increase consumer/buyer confidence (and that of the verifying authorities).
- The profits and annual turnovers are publicly available (reported) per company, but that does not provide an insight into the costs and profits of separate operative processes, for outsiders or for business colleagues.
- The meat industry does not have a centralised and transparent communication system, and as such a shared platform could be advantageous.

General background:

- The 2005 animal transport law needs changing.
- The changes need to be evidence-based.
- In the most part, the existing research and focus is on animal welfare, clearly proving the need to limit transportation as much as possible.
- The economic drivers of live animal trade (and meat commerce) are mentioned in official EU documents, but proper calculations on cost-effectiveness are lacking.
- The environmental impact of general transportation is well documented, but the live animal and carcass trade are not well studied.
- There is a void of evidence regarding the social impact of the carcass meat versus the live animal trade, with a lack of research comparing them, or showing the value of the former as an alternate and advantageous approach.

1.2. The aim of this research

The aim of this research was to consider the business case for a change to the export of carcass meat instead of live animals from the EU to third countries. The business case would include the current economic, environmental, and societal challenges and opportunities that these different approaches present, together with forecasts of future trends. Country case studies would be utilised to model the data captured. Although animal transportation has been made increasingly accessible due to the development of the transportation industry and technologies, neither its sustainability nor its economic benefits have been equitably explored to date. To fill this void, the purpose of this research was to comparatively calculate the costs, show the environmental impact, and consider the social implications of a carcass versus live animal trade, on the background of the current situation and foreseen future trends, through the case examples researched and the economic model applied.

Who needs this research?

- The EU, to inform policy and decision making through an evidence-based approach to close the current gap in information in this area;
- The industry, to have access to an analysis of the costs and benefits, to inform them in assessing any risks and opportunities linked to transitioning from the live animal trade toward carcass meat commerce, which in turn will enable them to limit the live animal trade;
- Animal welfare organisations to provide a broader and more informed view and insights regarding the issue;
- Meat consumers, to support and enable informed choices in their dietary decisions, through providing an overview of the elements involved;
- The animals.

In this era of unprecedented access to data and an abundance of information, there is a requirement for businesses to provide transparency, not only about their financial situation (cash-flow, profit) but also regarding their production technologies and practices. The informed choice of the customer is becoming increasingly important, especially in the food industry, for example, animal welfare considerations are beginning to shape some consumers' buying decisions. With all this in place, it may be expected that the industry stakeholders have all the data they need for market research, commercial calculations, and business risk assessment; yet public information to compare the economic facets of carcass meat transportation to that of live animals is surprisingly scarce. Although the recommendation of supreme legislators (European Court of Auditors 2023a) clearly states the need to limit the live animal trade and gives the solution of meat transport instead, for large companies this represents a risk that is impossible to assess without the relevant information available. With all the sustaining structures already in place (breeding and quarantine farms, transport vehicles, solid export chains owned by third-country companies inside several EU Member States, and holding facilities, slaughterhouses, and even supermarket chains in their own country of destination) built over several years with the associated job creation, and currently operating smoothly, these enterprises control an lucrative cash-flow. For such investors it is understandably challenging to think about a change from live animal transport to that of carcass meat. For this kind of reorganisation these companies need solid research on the sustainability of this path proposed. Until now many cases for change were based on animal welfare considerations, without economic background to allow a proper risk assessment. It is a difficult task to undertake such research because the whole food chain in this situation is very complex and has a multitude of crucial points requiring consideration. Yet, this is a requirement needed by the industry, to be able to make informed choices with the risk margin reduced and as thin as possible.

Our research has been undertaken to contribute to filling the gap in this regard, with the clear understanding that without the objective calculation of the economic benefits (alongside the risks and

costs) each established business will not be able to make an informed decision and plan for the change that may be needed. Having a model framework, namely the work performed by the Wageningen University (Baltussen, 2017), the researchers have been able to explore and develop an economic model to build a business case to compare the costs of a carcass meat trade versus live animal in the most objective way. This work has also considered the environmental impact and social implications of both scenarios, to ensure that sustainability is a central consideration to meat production and consumption around the globe.

A huge benefit from this work is that it provides insight to enable the future development of economic modelling tools – for different transportation routes for the carcass meat industry not yet explored, but also for other areas such as assessing the costs of different food (or even non-alimentary) products.

Alongside the construction of a business case using economic modelling and regarding the environmental impact of the meat trade, we also explored the social implications of both scenarios (carcass meat transport versus live animals) and modelled the social implications possibly occurring during the transition from the live animal toward the meat trade and after its establishment.

1.3. Stages and methods of the project

To meet the aim of this study, a vast quantity of information was gathered, recorded, processed, and used in successive stages; this was achieved by employing several methods (Figure 1).

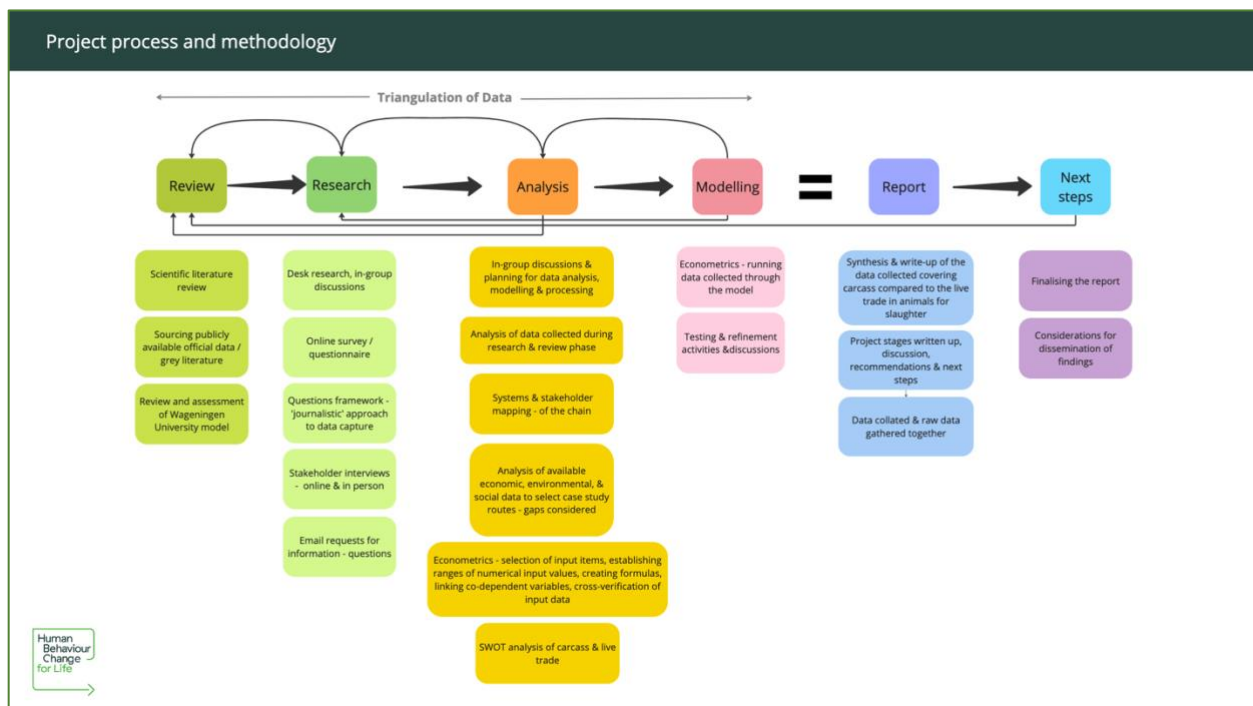


Figure 1. The stages and methods of the research project (please refer to Section 4.4 - Systems diagrams - to view this in detail).

The methods used for obtaining information can be classified into two broad categories, depending on how much real-time interaction they require. The **non-interactive desk research** included scientific literature review, data sourcing from official public data (formal reports, declarations, and publications of governmental and non-governmental organizations), and investigation of grey literature (newspaper articles, personal declarations, copyrighted and non-copyrighted website contents). The **interactive data collection** was based on interviews (mostly semi-structured, but unstructured and structured discussions as well), email exchanges (especially for follow-ups and additional details), questionnaires (structured and unstructured, open, and close-ended questions), and formal and informal discussions.

Some of the information obtained early in the project served to further develop and shape the interactive data collection and the research questions, this was to obtain a detailed image of the trading practices and their causes and effects. Regardless if the data was intended for the economic and environmental impact modelling, or to explore the social background, it was triangulated, and its accuracy compared through non-interactive and interactive methods (i.e., the same information was tested in interviews, researched in public databases, scientific literature, and even informal data sources, as much as it was possible).

After this qualitative processing, once the input variables were chosen and possible ranges estimated, the data was further used in the economic and environmental impact modelling. The model was constructed in a manner that allowed co-dependent variables to be linked for a proper simulation of different transport scenarios and to allow sensitivity analysis by consecutive trials.

To explore the social background of the carcass meat versus live animal trade the primary qualitative research performed was considered, including through the lens of human behavioural science and theory.

The results obtained from the economic and environmental impact modelling, and the societal data gathered, were interpreted, and included in a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis (Section 4.1.) to assist the development of a business case by presenting the contextual information covering the carcass meat compared to live animal trade.

2. Live animal and carcass trade: current situation and trends

Fundamentally, the meat industry (both live animal and carcass trade) is fuelled and controlled by the consumption of meat. To cover the animal protein demand of the globe's increasing population, over the past 50 years meat production has more than tripled and between 2000 and 2019 the world meat consumption per capita showed a statistically significant increase as well, from 29.5 kg/year to 34.0 kg/year (Whitton et al. 2021). Similarly, the Organisation for Economic Cooperation and Development (OECD) reports a total worldwide meat consumption of 34.04 kg/capita/year for 2022 (OECD, 2023).

Meat consumption differs from one country to another, and the consumers' preference for certain types of meat (the animal species). According to the OECD (2023) among the highest meat consumption per capita for 2022 was recorded in the United States of America (100.45 kg/year). Other countries with high consumption include Israel (91.57 kg/year), Australia (89.48 kg/year), Argentina (87.58 kg/year), and Chile (84 kg/year). Among the countries monitored by the OECD, the lowest meat consumption per capita for 2022 (OECD 2023) was found in Ethiopia (3.09 kg/year), followed by India (3.81 kg/year), and Nigeria (4.87 kg/year).

Over the past 20 years, the per capita overall meat consumption within the European Union (EU) showed a lower variation than 5 kg/capita per year (although the number of member countries changed), according to the European Commission's 2023 database (Figure 2).

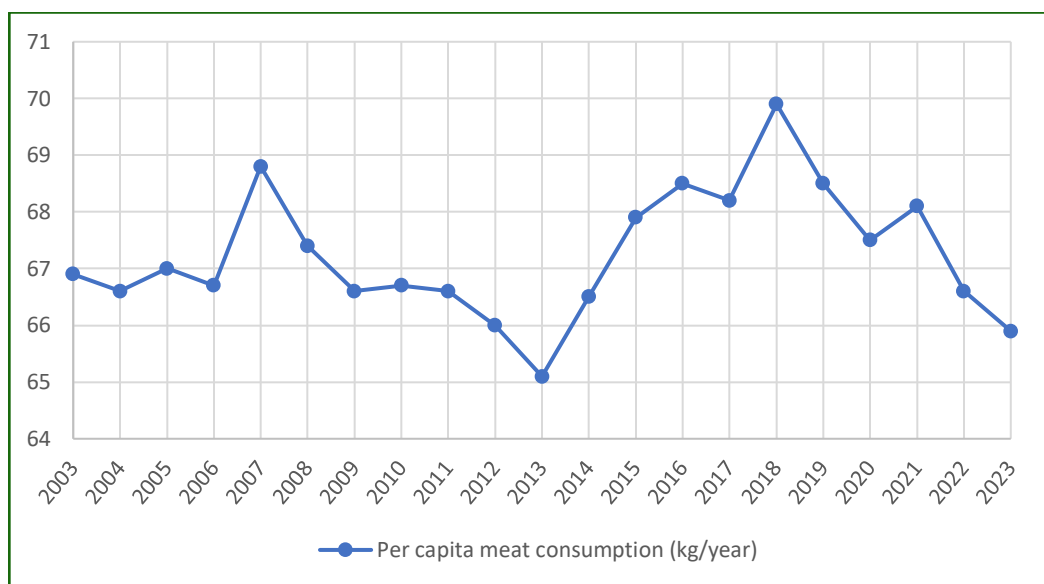


Figure 2. Yearly per capita meat consumption within the European Union between 2003 and 2023. Data source: EC, Directorate-General for Agriculture and Rural Development (EC Meat products short-term outlook, 2023).

Meat is one of the nutrients with high production costs and high output prices, and the growth of its global consumption is driven largely by income and population growth (OECD/FAO 2021). Yet, besides economic possibilities, cultural norms and beliefs can play a considerable role in alimentary choices, as shown by the example of India, home to the largest percentage of vegetarians in the population (Fischer 2023).

Regarding the preferred type of meat, the countries rank differently across the globe (Table 1).

Table 1. OECD monitored countries ranked according to their per capita consumption by type of meat in 2022. Data source: OECD (2023), Meat consumption (indicator). doi: 10.1787/fa290fd0-en (Accessed on 05 September 2023)

Beef and veal consumption			Pork consumption			Poultry consumption			Sheep consumption		
Rank	Country	Kg	Rank	Country	Kg	Rank	Country	Kg	Rank	Country	Kg
1	Argentina	36.9	1	Korea	31.7	1	Israel	65.4	1	Kazakhstan	8.4
2	United States of America	25.3	2	Viet Nam	26.8	2	United States of America	50.9	2	Australia	5.9
3	Brazil	24.5	3	China	25.4	3	Malaysia	50.1	3	Norway	4.4
4	Israel	23.4	4	Chile	25.2	4	Peru	47.4	4	Saudi Arabia	4.3
5	Chile	20.7	5	United States of America	23.8	5	Australia	44.5	5	Türkiye	4.2

Kg: kilograms/capita/2022

Considering the past 20 years (2003-2023) within the EU, the preference for beef and veal decreased steadily, approximately 12 kg to 10 kg per capita/year. Pork consumption had a more sinuous trend, with peaks above 35 kg per capita/year in 2002 and 2007, but since the last consumption peak in 2018 (34.5 kg), the trend is clearly decreasing with 31.8 kg per capita consumed in 2022, and 30.4 kg per capita forecasted for 2023 (European Commission, Directorate-General for Agriculture and Rural Development, EC-DGARD 2023a). Sheep and goat meat consumption consistently dropped from 2005 (2.1 kg per capita/year) to 2014 (1.4 kg per capita/year), then maintained this plateau to date. A preference for poultry meat has increasingly become the case in the EU. Its consumption increased from 17.8 kg per capita in 2003 to 23.2 kg per capita in 2022, and 24.1 kg per capita forecasted for 2023 (EC-DGARD 2023a). This substitution of red meat for poultry is possibly occurring because chicken is perceived as healthier, better for the environment, and cheaper (Whitton et al. 2021). The same trend is present worldwide, and the industry has adapted to the market demands. When examining the increase in the production of all major meat types, the poultry meat share rose from 12% in 1961 (Ritchie et al., 2017) to 38% in 2021, with the global shares of other meat products being lower (OECD/FAO 2021) (20% beef, 34% pork, and 5% sheep, respectively).

Based on the observation of these tendencies and taking into consideration a range of economic and social factors, the joint Agricultural Outlook of the OECD and the Food and Agriculture Organization of the United Nations (FAO) predicts the expansion of the global meat supply, reaching 374 million tonnes by 2030 (OECD/FAO 2021), and 382 million tonnes by 2032 (OECD/FAO 2023); an overall 14% of growth is projected for the global consumption of meat proteins over the next decade. However, the Outlook

forecasts that in high-income countries changes in consumer demographics, such as aging, and slower-growing populations will lead to a levelling off in per capita meat consumption and a move towards the consumption of higher-valued cuts of meat. As research shows (Vranken et al. 2014, Andreoli et al. 2021, Whitton et al. 2021, Parlasca and Qaim 2022) and official documents note (EU Agricultural Markets Briefs 2015, OECD/FAO 2021, OECD/FAO 2023), there is an inverted U-shaped relationship between per capita income and animal protein consumption. Up to a certain income level, meat consumption increases alongside the increase of economic capacity, but then it plateaus or even declines in the developed countries once superior economic stability has been achieved in most of the households. Thus, the 2023 OECD/FAO Outlook projects for the next decade that the meat demand and production will be led particularly by the upper middle-income countries. As populations and incomes grow, the low-income groups will consume a greater relative share of animal-based calories (OECD/FAO 2023).

According to the World Bank's 2022 data, there are 54 upper middle-income countries (Figure 3).

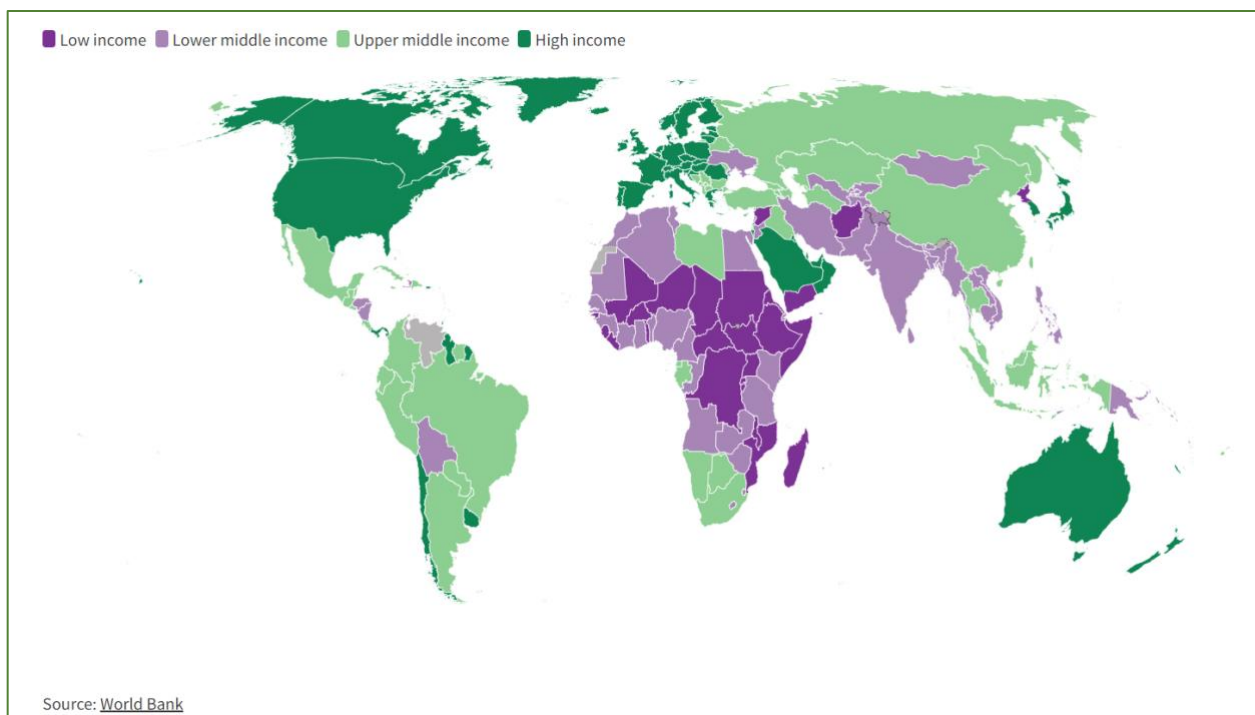


Figure 3. The world by income. Source: World Bank (<https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html>)

Based on FAO data, Ritchie et al. (Our World in Data 2017) graphically present the overall meat production worldwide (Figure 4).

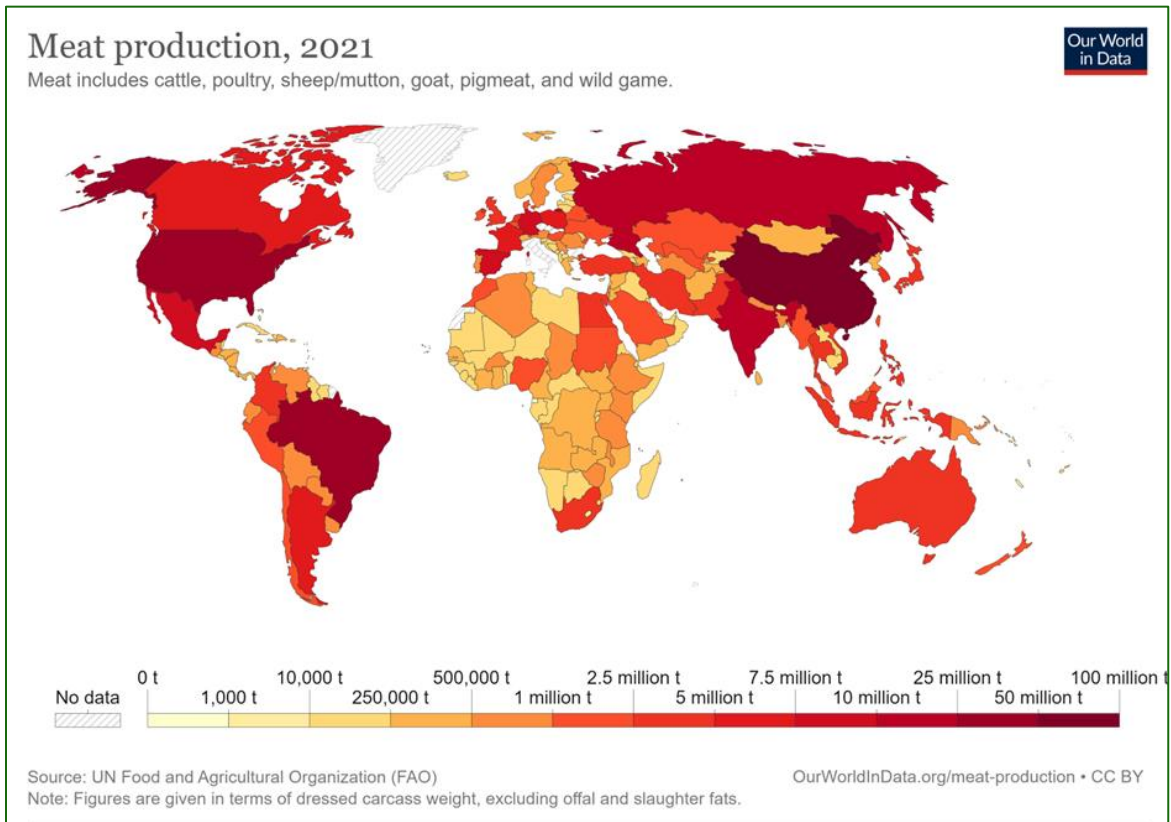


Figure 4. World countries ranked by their overall meat production (Source: OurWorldInData, 2017)

Comparing Figure 3 and Figure 4 it can be seen that some of the upper-middle-income countries (such as China, Russia, and Brazil) have a strong meat production industry, but that does not necessarily reflect a preparation by these countries to cover the increasing domestic meat market demand but to export. For example, Brazil was the second biggest meat exporter (beef, pork, and poultry) in the world in 2020 (Embrapa 2021), meaning that its meat production contributes substantially to the country's income (rather than the income being used to cover its population's increasing demand for animal protein). At the same time, high-income countries produce large amounts of meat that will be directed increasingly towards export as their domestic market for meat weakens. For example, a recent study (Stewart et al. 2021) monitoring the meat consumption in the United Kingdom for 11 years (2008-2018) in 15,655 participants found a significant ($p < 0.001$) decrease of the average daily meat intake per capita from 103.7 g to 86.3 g and a 7.0 reduction in processed meat consumption. Similar trend is reported in other developed countries too (Barnhill et al. 2022) and forecasted by the OECD/FAO Outcasts (2021, 2023). This work shows that the monetization of these assets relies on transporting them from one place to another: whether this be as live animals or carcasses and associated meat products. Unfortunately, this (alongside the necessity to transport animal feed to the breeding and fattening farms) adds even more to the meat industry's carbon footprint. As outlined by the OECD/FAO (2021, 2023) there are several upper-middle-income countries that have a low meat production (Figures 3 and 4) but a trend to increasing meat consumption, so unless either element of supply and demand changes within the country, a focus on increased transportation is likely. This is of great concern given the increasingly negative impact on the

environment being documented by such movement. According to the World Bank (Figure 3), almost all countries of the European continent are considered high-income countries, with strong economies. Several of these have high meat production (Figure 4). For example, in 2021 the overall meat production of Germany and Spain exceeded 7.5 million tonnes; Poland and France produced over 5 million tonnes, followed by the United Kingdom (4.18 million tonnes), and the Netherlands (3.04 million tonnes). The gross domestic meat production of the European Union in 2021 was 44.69 million tonnes, and the domestic use was 38.09 million tonnes (EC-DGARD 2023a). Meat exports from the EU peaked in 2020 (7.94 million tonnes) but fell sharply after (6.46 million tonnes in 2022, and only 5.9 million tonnes estimated for 2023), but in turn, live animal exports are increasing. According to the EC Directorate-General for Agriculture and Rural Development (2023a), the live animal exports from the EU to third countries had a sharp rise from 92.4 tonnes in 2007 to 359.2 million tonnes (carcass weight equivalent) in 2018, and even with the impact of the Covid 19 pandemic, these exports did not fall under 300 million tonnes to date (314 million tonnes being estimated for 2023).

2.1. Positives and negatives of the meat industry

Frequently overlooked is that each slice of meat sold, whether at a burger van, fast-food outlet, or indeed on a five-star restaurant's porcelain plate, carries a long and nuanced story, not only about people, animals, money, and the environment; but also, about beliefs, traditions, history, and change. At its basis, the whole meat industry was (and continues to be) set in motion by the commercial demand for certain food items, but the multilayered interdependent enterprise of the meat industry impacts far more than just the nourishment of those consuming the product (Bass 2021) in multiple ways.

Meat production

According to its encyclopaedia definition (Academic Accelerator 2023) the meat industry is a combination of primary (agricultural) and secondary (industrial) activities that are difficult to characterize strictly in terms of one or the other. It includes livestock farming for meat production, slaughtering, packaging, preservation, transport, and the sale of meat and meat products, with all the personnel involved in these stages. The transport activities cover both live animal and meat delivery. A major part of the meat industry is the meat packaging sector, which includes all the processing activities from the animals' arrival at a slaughterhouse, until the product's final selling, in the form of meat cuts, meat products, or various ready-to-eat dishes, for example in restaurants. The more work processes are involved in this chain, the more beneficiaries the industry has, and usually all the costs are reflected in the final price.

As Savell (2023) notes, meat production is an influential part of the world economy, contributing to local, national, and international trade. This industry can impact on sustainable economic and social development, representing the income source for over a billion employees around the globe (Parlasca and Qaim 2022), and supporting many livelihoods in developing countries (Herrero et al. 2013, Salmon et al. 2020). In a recent American study, Bass (2021) reports that the average production worker earnings in a meat processing facility, are over twice the 2020 United States federal hourly minimum wage. Moreover, after the products leave the facility the finished meat animal livestock delivery to packers and processors accounts for an estimated 2.9 million transportation delivery event opportunities, providing jobs for those in trucking and associated industries (Bass 2021). Citing FAOSTAT (2020) and The World Bank (2020)

Godde et al. (2021) synthesises that over 844 million people worldwide receive some income from agriculture, and the livestock sector contributes about 40% of agricultural value added, therefore contributing to the livelihood of many communities.

As long as the global biomass of livestock is twice that of human populations (Salmon et al. 2020), this sector uses a significant amount of land, water, and other resources, and has a considerable environmental impact. As Herrero et al. (2013) state, there is a concern about how to manage the sector's growth, so that its benefits can be attained at a lower environmental cost in these conditions where livestock and environment interactions can be both positive and negative. In Brazil, the third largest meat producer in the world (after China and the United States of America) a massive part of the original Amazon region has been deforested to obtain livestock pastures (França et al. 2021). Stewart et al. (2021) state that the livestock sector drives deforestation, land degradation, and biodiversity loss.

Yet, in some geographic areas, livestock production takes the natural assets of grassland and rain to produce edible protein whilst supporting biodiversity (Goodger 2021), and indeed ruminants can be grazed on land unsuitable for crops and fed crop residues, then dairy and meat production can provide environmental benefits through nutrient recycling (Clonan et al. 2016). Additionally, the proper use of manure as fertiliser minimizes nutrient pollution and contributes to the health of the soils (Herrero et al. 2013, Environmental Protection Agency of the US 2023) by replacing chemical fertilisers. However, if animal waste is not properly used or managed, it can pollute the lands, and surface- and deep waters (Gerba and Pepper 2009). Moreover, the methane produced by the intra-ruminal microbial fermentation and emitted, is more than 25 times as potent greenhouse gas as carbon dioxide at trapping the heat in the atmosphere (EPA US 2023). A typical dairy cow releases about 160 kg of methane per year and 27% of the estimated global anthropogenic methane emissions are produced by ruminant enteric fermentation (American Society for Microbiology 2023). Although methane is a potent gas, it is shorter-lived than carbon dioxide, thus achieving its considerable reduction would have a rapid and significant effect on atmospheric warming potential (EPA US 2023). As for carbon dioxide, in a very comprehensive study (with a data set covering approximately 38,700 commercially viable farms in 119 countries), Poore and Nemecek (2018) report that ninetieth-percentile greenhouse gas emissions of beef are 105 kg of carbon dioxide per 100 g of protein.

One of the costs impacting the profit (and livelihood quality) of farmers involved in livestock production is the price of feed and fodder needed by the animals to obtain good production. Many livestock farms, especially those with industrial settings produce the feed and fodder for their livestock on their own to reduce the costs, as the feed and supplements are the most expensive items in an animal farm, comprising 75 percent of the cattle farm expenses in 2021 (USDA 2022). Due to the various meteo-climatic conditions, the crop and hay production (like pasture quality), can vary from one year to another, causing price fluctuations difficult to foresee. Figure 6 exemplifies the cattle feed and fodder price variations recorded between 2012 and 2022 in the United States.

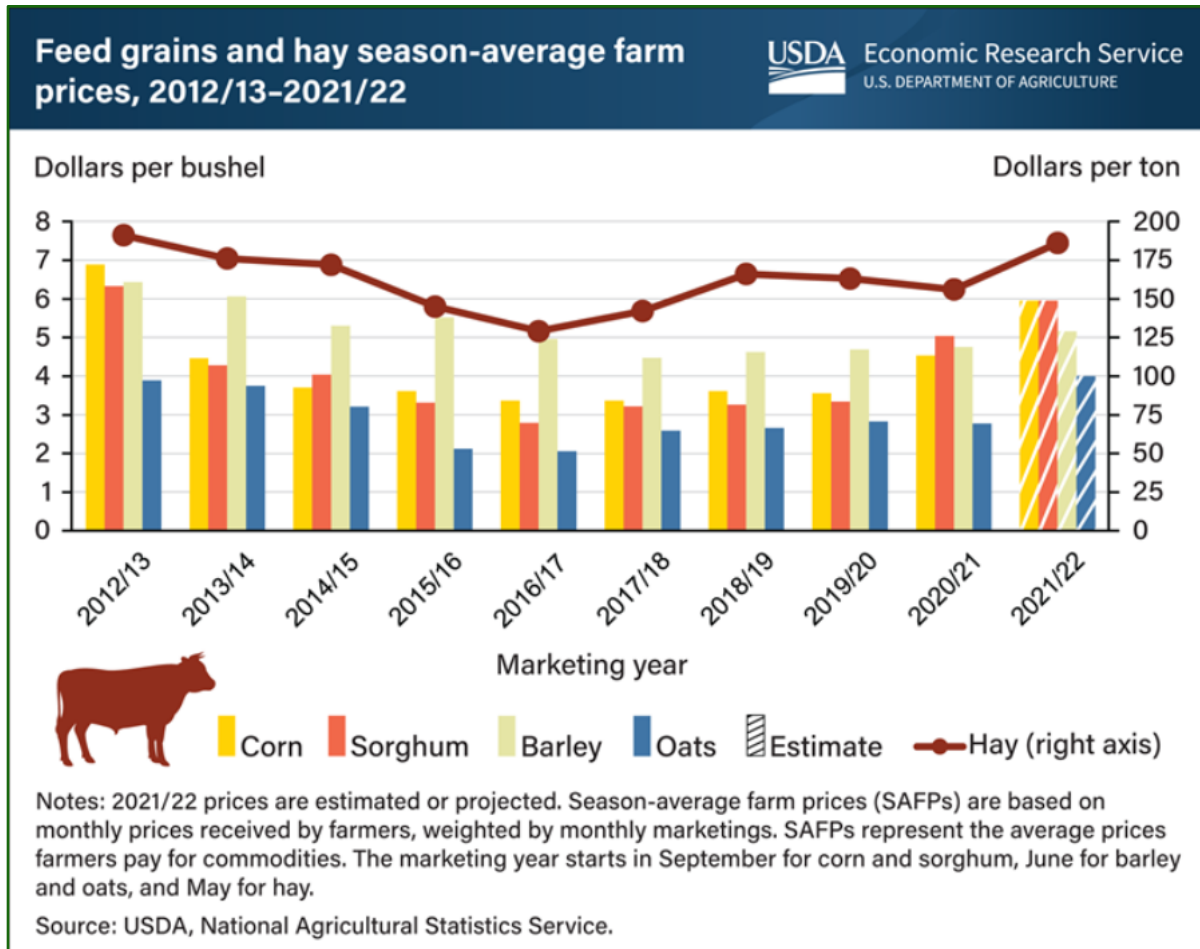


Figure 5. Cattle feed costs between 2012 and 2022. Source: <https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=104424>

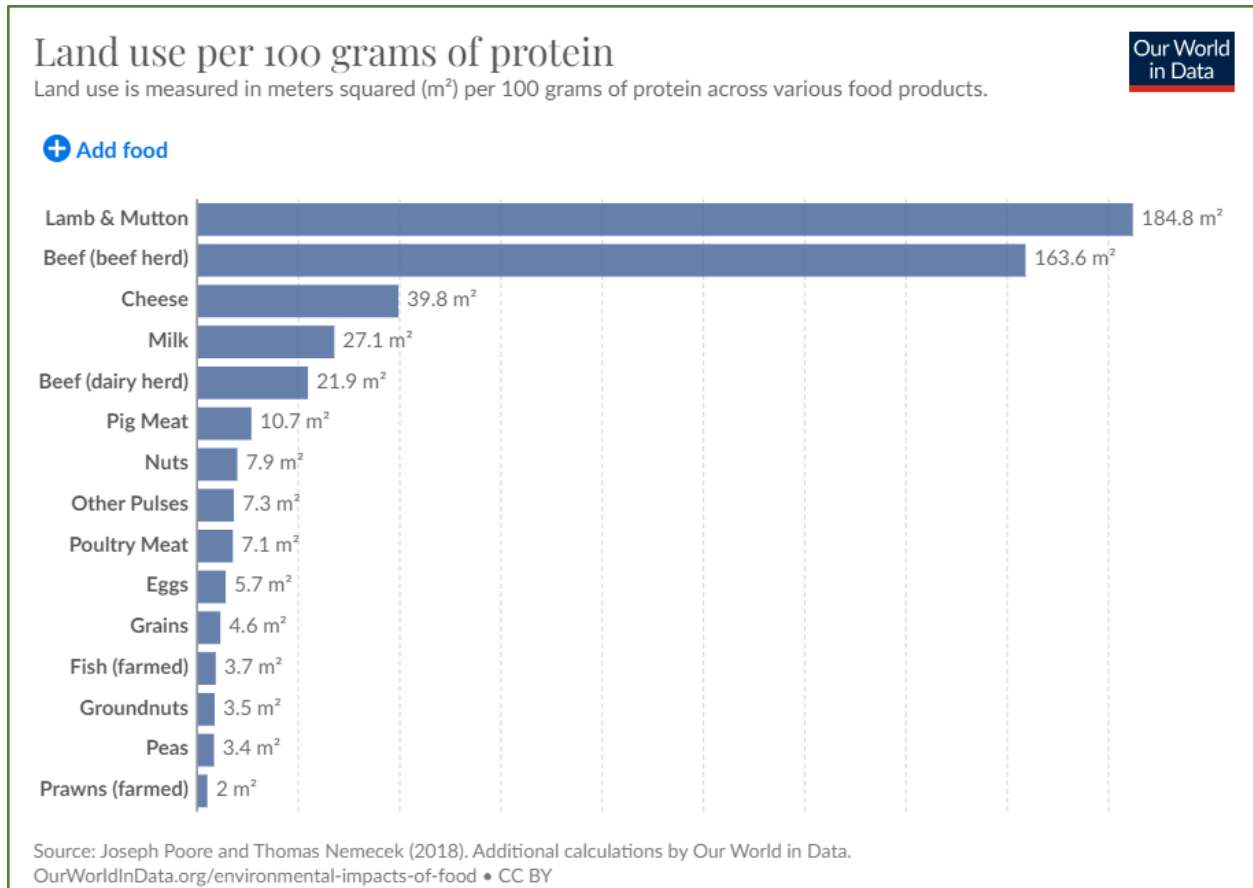


Figure 6. Land use per 100 grams of protein (OurWorldInData 2019)

According to a 2016 press release of the International Union for Conservation of Nature (IUCN), three-quarters of the world's threatened species are placed at risk from agriculture, land conversion and overharvesting. Although it brings the benefit of high yields, and regardless of the production is destined to feed animals or people, intensive agriculture (by excessive fertilisation, improper use of pesticides and the use of heavy machinery) can lead to soil acidification, nitrification, desertification, decline in its organic matter, soil contamination, erosion and compaction (Alexandridis et al. 2018). Of the animal and plant species on the organisation's Red List (list of threatened species), 62% are threatened by agricultural activity (the production of food, fodder, fibre, and fuel crops; livestock farming; aquaculture; and the cultivation of trees), and climate change, partly anthropogenic, endangers an additional 19 percentages. The extinction of plants is also a concern because many of the more than 70 wild relatives of some of the world's most important crops, which are at risk have highly necessary genetic resources for more resilient and productive crop breeding. For exemplification, listed among the threatened plant species at highest risk of extinction are all eight species of *Vanilla*, 92% of cotton (*Gossypium*) and 60% of avocado (*Persea*) species. The causes of this impending catastrophe include the conversion of wild habitats for human use, the shift from traditional agriculture to mechanisation, widespread use of herbicides and pesticides, and, finally, the invasive species and pests (Goettsch et al. 2021). Whether growing plants or rearing animals, biodiversity can be lost (Yazbec IUCN press release 2021).

Food competition between farm animals and people is cited many times, considering cereals in the first place (e.g., reviewed in Paola et al. 2017). Yet, especially in case of ruminants, the meat production system

can convert grass and crop residues that are not edible for humans into food, hence contributing to food security (Parlasca and Qaim 2022). This adds to the importance of choosing the production types according to local and national possibilities for achieving the most feasible usage of natural reserves, both economically and as environmental protection and resilience. Unfortunately, in many situations, the animal and vegetal farms are located at a distance imposing the need to transport feed and fodder. Not only do the costs of transportation increase the rearing costs of livestock (consequently increasing the price of the final product), but it also impacts the environment. The transport sector is a major contributor to greenhouse gas emissions, accounting for approximately 20 percent of carbon dioxide emissions globally, and road transportation produces the majority of those emissions (Albuquerque et al. 2020). Yet, in the case of food products (not live animals), transport emissions are small when compared along the supply chain, as shown (Figure 7) in a recent publication by Ritchie (2023). There are numerous ways in which transport negatively impacts live animals. Just a few examples are: exhaustion (animals have to brace themselves and balance); poor handling (standards of driving and handling may be inconsistent among regions and time periods); stress (especially for animals that have previously not been handled much by humans, which is the case for most meat-producing livestock); insufficient attention of the operators to load only animals fit for transport (especially when high numbers are transported in uniform groups, such as sheep); and heat stress (especially considering climate change regarding longer summer seasons and extreme temperatures). From the profitability point of view, it is well known that animals lose weight during transportation. In shorter journeys and good conditions, this is mostly represented by eliminating the gut-fill, but with higher stress (long journeys included) the weight loss can lower the value of the animals and thus the profit of the industry operator. Among the worst effects of live animal transport, dehydration, heat stress and trauma produce the highest commercial losses, occurring especially in long distance transport. These can increase the number of animals refused at destination (and euthanized and discarded) or cause death, possibly leading to mortality rates that must be officially reported, according to national and international laws. Besides the economic loss in the number of animals, these events can attract bans for the transporter company and/or temporary or final prohibition from this activity.

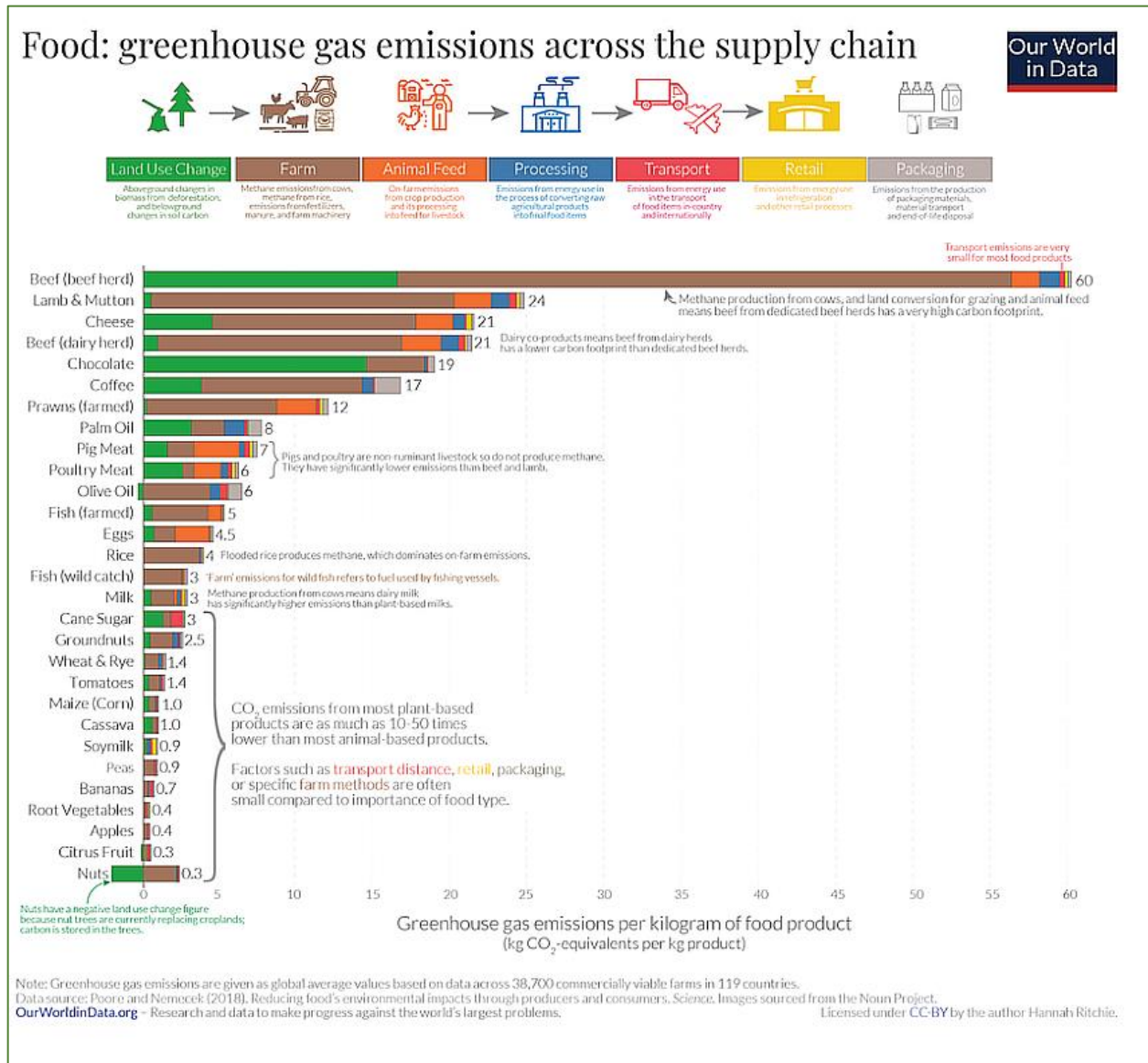


Figure 7. Source: OurWorldInData 2020

Water usage is another major effect of livestock production, and generally of agricultural activities. In the context of agriculture intensification to meet the food demand of our growing population the water requirements increase the water resource use competition and produce more or less extended local water stress (Ran et al. 2017). Heinke et al. (2020) estimate that annually, 4,387 km³ of blue and green water is used to produce livestock feed, equalling about 41% of total agricultural water use. Regarding the consumptive water use (CWU) in an animal farm (withdrawal water: water withdrawn from a watershed and not discharged to the same watershed, being evaporated, embodied in plants or animals, or discharged in a different watershed) Ran et al. (2017) documented that > 98% of its total in livestock production can be attributed to evapotranspiration from feed crops and pastures and only 2–8% of livestock CWU is drinking, servicing and feed-mixing water. However, the calculations made by Ritchie and Roser (2017) show a high variation of freshwater withdrawal for different foods (Figure 8).

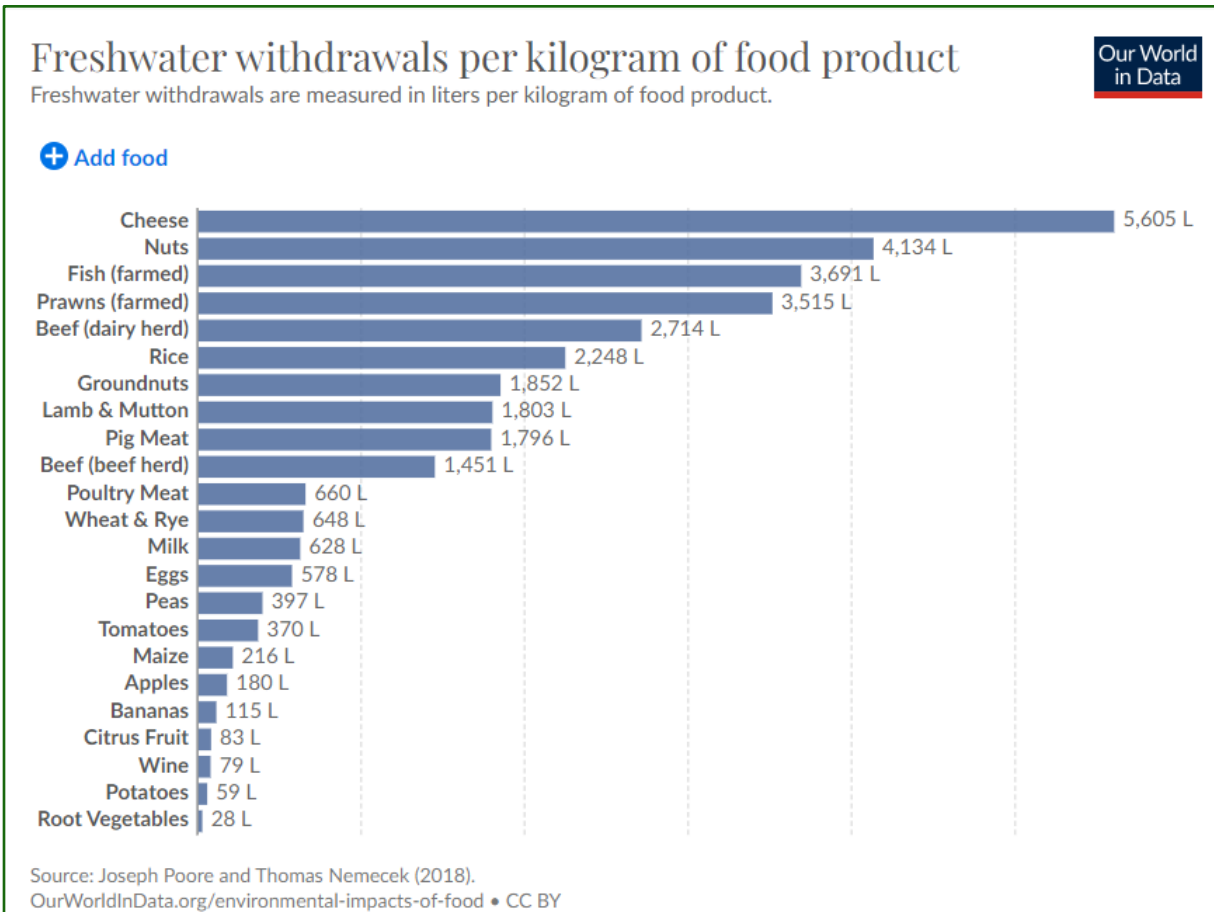


Figure 8. Source: OurWorldInData 2017

Because all the resources needed and involved costs, both industry and science aimed at the highest possible efficiency. Thus, throughout history, livestock breeds have been selected for performance. Alongside the benefits of stable traits that brought higher yields, less susceptibility to diseases, enhanced quality of produces and better sustainability of the food chain came the disadvantages of breed variety and original trait losses (restricted genetic pools, extinction of ancient breeds), higher risk to certain (new) diseases, little if any control over genetic mutations, increased possibility of genetic depression (and consequently the increase of negative mutations) and, in case of the animals physical and metabolic discomfort (Regoli 2015).

One of the main topics discussed increasingly in connection with the meat industry is animal welfare, from the ethical, moral and scientific point of view. From the very beginning of consolidation of this domain as a science, farm animals have been at its focal point. Ruth Harrison's "Animal Machines" book (1964), Brambell's report (1965) laying the foundation of the Five Freedoms of Animal Welfare (developed later into the Five Domains concept system), laws and regulations emerging since these first official concerns, had as main preoccupation the farm animals. The dramatically negative impact of intensive farming systems on animals is well documented, also the effects of their transport, various production enhancing technologies and slaughter. Animal welfare laws are meant to protect livestock species, science proves the importance of welfare for their management and productivity and the industry shows significant improvements along the production chain for the past half century. It is a system with various feed-back

loops that reached the level to impact the food industry, especially that of the meat. One of the main reasons noted in the OECD/FAO forecasts (2021, 2023) for lowering meat demand trends of the high-income countries in the following decade is the consumers' ethical standpoint toward animal welfare.

In a study Kernebeek et al. (1995) concerned by the triple need for our global society to increase land productivity, reduce waste and shift human diets used linear programming to determine minimum land required to feed large populations. As their results show, land is used most efficiently if people derive 12% of their dietary protein from animals, especially milk. Below this value the human-inedible products are wasted (i.e., not used for food production), and above it additional crops must be cultivated to feed livestock. A population of 40 million or more can be sustained only if animal protein is consumed, in the opinion of the authors. They conclude that land use would be lowest at a consumption of 12% animal protein, because at this level animals optimally consume co-products from other food products intended for humans. However, with a higher relative share of lands unsuitable for crop production larger populations can be sustained only with diets relatively high in animal proteins.

As a general conclusion, a multifaceted approach is needed to achieve a more sustainable livelihood for all humans on earth.

2.2. The meat trade for cattle and sheep between Europe and third countries

Both cattle and sheep produce red meat. As shown by records and forecasted trends of OECD/FAO (2021, 2023), the global demand for sheep meat is stable but moderate compared to other meat types and slightly decreasing for beef. This is particularly evident in high-income countries. Reasons for this may include changes to dietary behaviour. From the health advice of the WHO and national health authorities recommending limiting red (and processed) meat intake, to the awareness of the lower environmental impact of poultry production and animal welfare considerations, ending with the simple taste preference of the final consumer, all can play a role. The higher welfare concerns for mammals than for birds may be explained by the general tendency observed (Miralles et al. 2019) that human empathy and compassion toward other species decrease with evolutionary divergence time and/or the perceived differences between mammals and birds in at least some of the four main human empathy-driving animal characteristics identified (Palhus 2022): (1) perceived intelligence, (2) size, (3) aesthetic appeal, and (4) lack of harmfulness.

However, besides these considerations and many times overlooked by the production companies, several religions have dietary prescriptions that can markedly influence the food choices of large human populations as well. As such, vegetarianism is promoted by Hinduism, Buddhism and Jainism, leading to decreased meat demands in the countries with a high number of followers and, consequently, rendering these less important for the meat industry. On the other hand, a growing meat market is developing in Central Asia, the entire Middle East, Western Asia, North Africa and many countries in West Africa, South Asia and Maritime Southeast Asia, represented by the Jewish population in Israel and, majority Muslim countries in the other named geographical regions (except for Armenia). The 2010-2030 projections for the future of the global Muslim population (Grim and Karim 2011) show that Muslims will make up 26.4% of the world's total projected population (8.3 billion by 2030), with around 2.8 billion Muslims by mid-

century. The growing population and rising income levels are forecasted to increase the consumption of higher-value foods, rich in animal proteins, especially meat in countries with high numbers of Muslims, as shown by Attwood et al. (2023). Thus, the global Halal food (permissible to be eaten by Muslims) market is forecasted to reach US\$1.67 trillion by 2025. The criteria for any food to be Halal are laid in The Quran.

The other religious group with clear food consumption laws (rooted in the Torah, Kosher food) is represented by the Jewish community. With Israel the only explicitly Jewish state and majority of Jews (around 6.9 million), in 2021 the number of self-declared Jews not identifying with another religion worldwide stood at approximately 15.2 million, with around 10 million additional people who are eligible for Israeli citizenship under their Law of Return (The Jewish Agency for Israel 2021). While the global Halal food market was valued at US\$ 1.27 trillion in 2021, global Kosher market revenue was close to US\$ 20 billion in 2021 (Attwood et al. 2023). Israel has one of the highest overall meat consumption per capita in the world. To ensure the stable availability of food due to its limited arable land and water resources, Israel is highly dependent on agricultural and food imports, relying mainly on sea shipments (Shaked and Akingbe 2022 2022). Similarly, trade imbalance represents a potential food security risk for many Halal food markets, especially in the Muslim-majority countries situated in the Gulf region with limited domestic livestock farming. These countries currently import over 85% of their overall food and 62% of their meat (Attwood et al. 2023).

The largest halal meat exporter to the Organization of Islamic Cooperation (OIC) countries is Brazil, followed by Australia and India, and the biggest European exporters are France, the Netherlands and Spain (Euromeat, 2023). As regards Kosher food, the Israeli importers search for an acceptable balance between quality and price in their selection: the products from the U.S (United States) tend to have relatively high production and freight costs, and the products from Europe, the Mediterranean and Black Sea Basin - have the advantage of proximity and, in some cases, lower production costs (Office of Agricultural Affairs, U.S. Embassy 2019).

When exported to Muslim or Jewish communities, both Halal and Kosher food have to be authorised by the destination authority's representatives to ensure its compliance with the religious requirements, this must also be labelled accordingly as well. In meat production, this means the fulfilment of several specific criteria, including the direct and active participation in the slaughter of an adult Moslem to obtain Halal meat and, of a 'Shohet' (a person officially certified as competent to kill ruminants and poultry in the manner prescribed by Jewish law) for the meat to be Glatt Kosher. Probably because of the wide reach of Islam, the number of foreign Halal certification bodies is significant. Each destination country has certification bodies in the source countries where slaughter will take place, so that the meat can be certified as Halal and then imported. For example, Indonesia which is a majority Muslim country, has such certification bodies in 23 countries (33 for slaughtering cattle, 34 for food processing and 15 for flavour production). As for the Kosher certification, it is a legal requirement for importing beef, poultry and other meat and products into Israel (import of non-kosher meat and meat products is prohibited), and only the Chief Rabbinate of Israel can approve a product as kosher for consumption in Israel, or another supervisory body authorised by the Chief Rabbinate. Also, the slaughterhouses producing meat or poultry products for Israel must be registered with the Israeli authorities (Shay and Tate 2018). The conclusion is that to sell meat to the Muslim and/or Jewish community, the meat industry must fulfil the requirements specific to these communities, for the products to be accepted on these markets. Ahmed (2022) notes that almost 85% of Halal food is provided by non-Muslim countries and Needham (2012) reports, similarly, that some European countries produce Halal and Kosher meat for export.

There is more publicly available Islamic guidance covering the rearing conditions of meat-producing animals than Jewish. As the Islamic Services of America (2021) describes, to be Halal, animals must be raised in a healthy, clean, and humane environment. If the animals are in an unclean or abusive environment, they must be removed and nurtured back to a healthy and detoxified state prior to slaughter. This requirement is rooted in the Hadith (Prophetic Traditions) of Prophet Muhammad outlining that *'A good deed done to an animal is as meritorious as a good deed done to a human being, while an act of cruelty to an animal is as bad as an act of cruelty to a human being.'* Although not the same explicitly, Judaism also advocates for the proper treatment of animals by banning the 'Tza'ar Ba'alei Chayim' (suffering of living creatures) so much that even castration of male pets is prohibited (also declawing, tail and ear docking, and any other physical alteration without a legitimate need). The Torah even permits to an extent the violation of Sabbath to rescue an animal in pain or at risk of death. For example, they can be moved if in pain, a Jewish person can use objects that would not be permitted to be touched otherwise to relieve their pain, medicines can be given, and non-Jewish people can be asked to intervene in ways that would violate Shabbat to help a suffering animal (Judaism 101 n.d.). Proper and good treatment of animals is a basic element of both the Jewish and Muslim religious texts (Needham 2012).

However, the most debated element of Islamic and Judaic religious slaughter is the killing method of the animal to produce commercial Halal and Kosher meat, specifically the performance or lack of the pre-slaughter stunning (Needham 2012, Farouk 2013, Savell 2013, Kagan et al. 2020, Riaz et al. 2021). In this regard, the main difference is that Halal asks for the animal to only be alive pre-slaughter, and thus allows certain pre-slaughter stunning procedures, with the condition that it does not stop the animal's heart and, if not killed, the animal will return to full consciousness and health. Whereas Kosher requires the animals to be both alive and conscious pre-slaughter - thus it renders any mechanical or electrical methods of pre-slaughter now or in the future unacceptable (Farouk 2013, Savell 2013). Table 2 presents a comparison of publicly available information regarding the ideological and practical similarities and differences involved in the production of Halal and Kosher meat.

Table 2. Comparisons between the theoretical and practical aspects of Halal and Kosher meat production

Halal	Kosher
There needs to be an intention to slaughter for human consumption, thus it cannot be mechanical, by a machine (ISA 2021).	The Torah's commandment is that 'whoever wishes to eat meat must first slaughter the animal, as it is written' (Appel 2022, from Deuteronomy 12:21).
The animal has to be healthy and should not be hungry or thirsty at slaughter time (TAMU 2019).	The animal must be healthy at the time of slaughter, must not have organic defects (congenitally or non-congenitally missing organs, perforation, laceration or tearing of vital or certain organs), must not have lesions caused by a fall or predatory attack, and must not have fractures. All pre-slaughter procedures (electric, traumatic, or anaesthetic stunning) are forbidden as these may endanger the health and life of the animal (Appel 2022).
The animal needs to only be alive pre-slaughter (i.e., not conscious too); thus, stunning is accepted (Savell 2013).	The animal must be alive and conscious pre-slaughter; thus, stunning is not accepted (Savell 2013).

Halal	Kosher
The knife must be sharp to cause as little pain as possible, but it must not be sharpened in front of the animal.	The killing (Shehitah) must be done by a swift, smooth cut of a sharp knife whose blade is free of any dent or imperfection, severing the trachea and the oesophagus and it is forbidden to slaughter the parent with its young on the same day (Appel 2022).
The animals must not see another animal to be slaughtered, each is processed one at a time (ISA 2021).	
The animals can be slaughtered by any sane Muslim, male or female, who is acquainted with the process (AHF 2022), and also by faithful Christians and Jews ('People of the Book') (Savell 2013).	The animals have to be slaughtered by a Shohet (Savell 2013), a specially trained, pious (observant) Jew, who can be a Rabbi in the same person (TAMU). The shohet must receive written authorisation from a recognised rabbinical authority attesting his qualifications (Appel 2022)
The name of Allah has to be mentioned before or during each slaughtering (prayer) by a member of the Moslem faith who is facing Mekkah (TAMU 2019, AHF 2022).	It is sufficient to recite the name of Yahweh (God) and offer prayer (blessing) on the first animal/bird and the last one in the lot of slaughtered animals/birds of the day (AHF 2022).
Eating Halal meat is fully allowed by Allah (AHF 2022)	Eating meat is a sort of compromise, a divine concession to human weakness and human need (Deuteronomy 12:20-21; 23-24, AHF 2022), a temporary dispensation until a future ideal state just as at the initial period [before Noah] in which people and animals will not eat flesh, as no one shall hurt nor destroy another living creature (Kook referenced by Schwartz n.d.)
Islam considers the entire cattle or sheep as Halal if duly slaughtered (AHF 2022)	The sciatic nerve and associated blood vessels and certain kind of fat deposits in the hindquarter are not Kosher. Practically, only the forequarter is consumed as the removal of Treifa (non-Kosher) parts is labour and time intensive, increasing the production costs (AHF 2022)
Death (stopping the heart) must be through blood loss, the blood must be completely drawn from the carcass, but residual blood in the meat is acceptable (Savell 2013, AHF 2022)	The animal has to be exsanguinated and all residual blood must be purged (kosherization, by soaking in salted water); all haemorrhages found at the post-slaughter examination are rejected (Savell 2013, TAMU 2019, AHF 2022)
Kosher meat is Halal (Farouk 2013, Savell 2013)	Halal meat is not Kosher (Farouk 2013, Savell 2013)

ISA: Islamic Services of America, TAMU: Texas A&M University, AHF: American Halal Foundation,

The protection of animals at the time of killing in the EU is controlled by the Council Regulation (EC) No 1099/2009. This regulation states that *'Many killing methods are painful for animals. Stunning is therefore necessary to induce a lack of consciousness and sensibility before, or at the same time as, the animals are killed'* (Art 20). Due to respect for the freedom of religion and the right to manifest religion or belief in

worship, teaching, practice and observance, the EC grants exceptions from stunning animals prior to slaughtering for religious slaughter taking place in slaughterhouses. Although it is essential to acknowledge that animal welfare NGOs may not agree with this practise, the possibility of derogations given by the European Regulation (EC No 1099/2009) shows that slaughter without stunning is a reality. However, this leaves a certain level of autonomy to each Member State (Art 18), to strike the right balance between care for animal welfare and the protection of the freedom to manifest religion (Vinci et al. 2023). In a recent analysis of the European Parliamentary Research Service Vinci et al. (2023) lists the practices of religious slaughter in the Member States (Annex 7), showing that most EU Member States use the derogation provided, except for Denmark, Slovenia, Sweden, and the Wallonia region of Belgium; while other Member States use it with conditions (requesting post-cut stunning): Flanders Belgian region, Estonia, Greece, Latvia, the Netherlands, Austria, Slovakia and Finland. In trading partner countries stunning is compulsory even for ritual/religious slaughter of all species in Iceland, Norway and Switzerland. Lichtenstein and New Zealand allow slaughter without previous stunning only to obtain Kosher meat from poultry. India allows the slaughter without stunning, but cattle slaughter is banned nationwide except in the state of Jammu and Kashmir (Vinci et al. 2023). The only possibility for these countries to establish meat-trading relationships with Muslim or Jewish communities is to sell and transport live animals in those countries that allow religious slaughter. The practice of live animal transportation is likely to increase even more as there are indications that religious slaughter may be banned in further EU countries, because of the public concern for animal suffering, attracting the criticism of religious groups. Thus, it is not a surprise that between 2017 and 2021 a mean number of 212.7 million live exports took place yearly from the EU, accounting for 13.5% of all cross-border animal movements (European Court of Auditors 2023b, EC-DGARD 2023b). Yet, in 2022 the meat and edible meat offal exports from EU to third countries significantly exceeded that of live animals (Figure 9, Eurostat 2023), demonstrating that meat production and meat transport is possible and already in place (Figure 9), as a sustainable alternative to live animal transport, even for Kosher and Muslim markets.

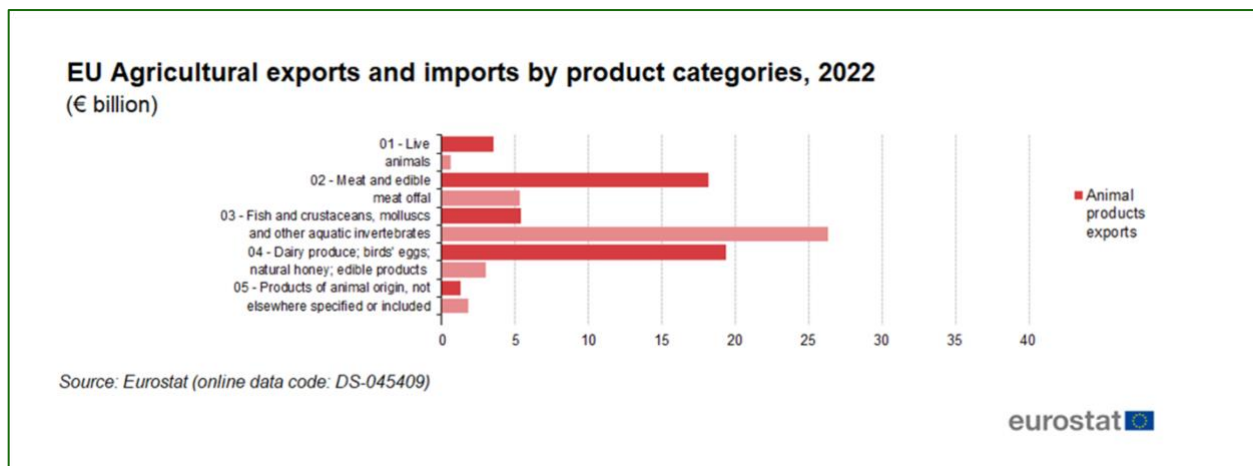


Figure 9. EU animal product exports and imports in 2022 in billion euros. Adapted from Eurostat 2023

The possibility of transporting carcasses rather than live animals is more evident in the European exports to third countries of cattle (Figure 10) compared to sheep (Figure 11). Considering the values shown in these Figures (10 and 11), it must be considered that for live animals their live weight is considered, which exceeds at least 40 % of the carcasses (non-edible offal). This difference is lost once the animals are slaughtered in the destination country to obtain carcasses. The other loss added in case of Kosher meat

production is that of the hindquarters, which must be sold as non-Kosher (at a lower price) in the destination country. Whereas, the carcass weight can be considered net weight, which can be capitalised wholly in the destination country. When meat is transported, the non-Kosher parts of the animal could be sold on the non-Kosher market in the origin country, to avoid unnecessary transport costs.

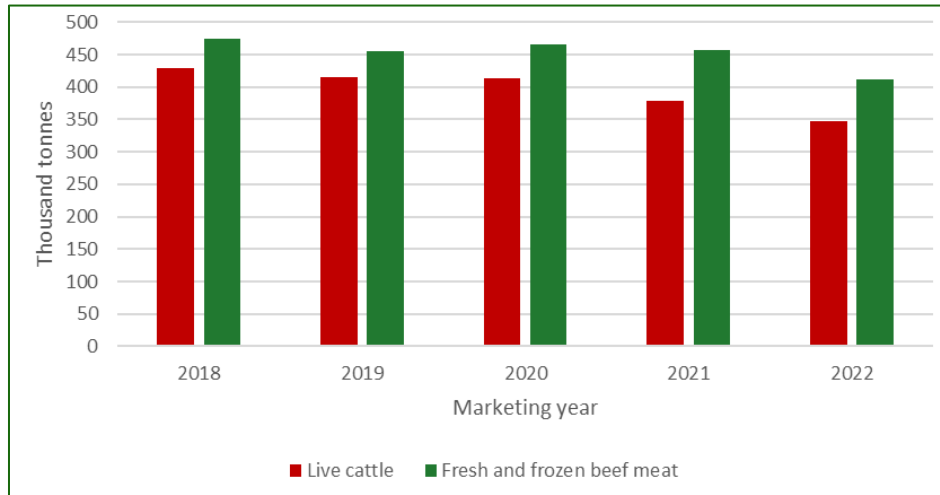


Figure 10. Live cattle and beef exports from the EU to third countries between 2018 and 2022. Data source: EC, Directorate-General for Agriculture and Rural Development (2023c)

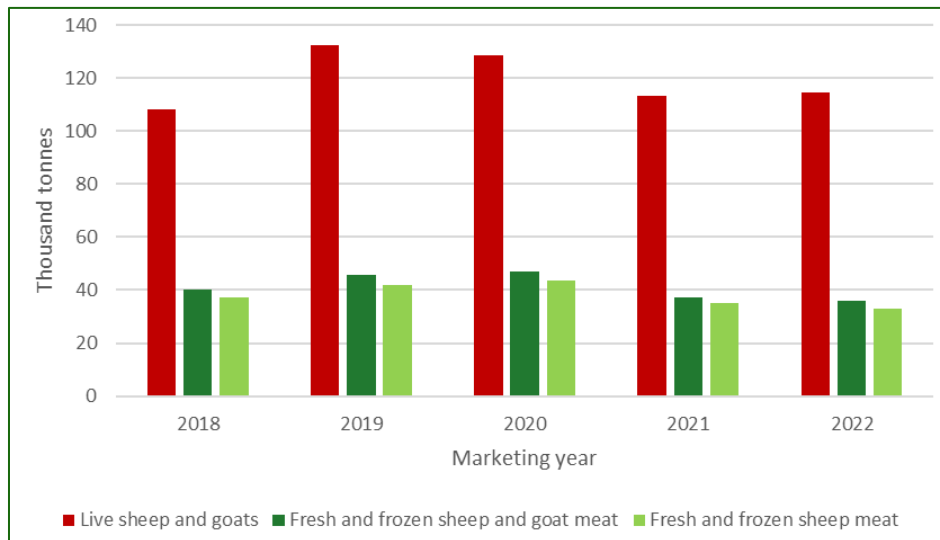


Figure 11. European to third countries exports compared between live sheep and goats to sheep and goat meat and to fresh and frozen sheep meat from 2018 to 2022. Data source: EC, Directorate-General for Agriculture and Rural Development (2023d)

3. Route exploration and selection

3.1. Methodology

To perform an economic study and develop a business case for a carcass trade over a live trade in animals transported from the European Union (EU) to third countries selection criteria were developed; for example, this included the market capacity and trends have been assessed over the past five years. It was important to ensure that the data associated with different contexts can be compared and bias can be reduced as much as possible, while taking into account that cost differences exist between the Member States. To this end, the countries having commercial relationships with third countries and performing both a carcass and live animal trade were selected for this research. Other selection criteria included consideration of the current meat production for both the origin and destination countries, and whether the research team had access to contacts who could provide relevant information about the trade for each route. It was important to have contacts who were resident in the countries being studied with reference to language skills and publicly available national data – which is more accessible in each country's official language. In addition, the benefit of having in-country contacts to provide informed insight into the local context added a broader perspective, value and comprehension to the public data.

The methods employed in this stage of the research included: desk research by the research team; discussions with representatives of organisations interested in the trade in animals from the EU to third countries in Europe; and a short survey completed by organisations working in this field. For the desk research, the major data sources used were the World Bank database and the European Commission's Agri-food data portal. Semi-structured discussions followed the first desk research stage and helped in narrowing down the selection options. Following this, further discussion was undertaken to synthesise the survey and desk research results to shape the final research direction for selecting the origin and destination countries, and the traded animal species. The selection options excluded early during the project will not be presented in this report.

The survey included multiple-choice and open-ended questions to facilitate the collection of as much information as possible. The respondents were asked not only about their opinions (about farm animal species to focus on, destination countries, journey means and durations, animal welfare problems during transport, after arrival and at the slaughter point, and trade data availability) but also to provide justification for their answers including any relevant information.

3.2. Routes and animal species

France: survey and desk research results

When asked about which animal species should be the focus of a case example for this research project, 66% of the respondents indicated cattle. The justifications for this answer were grouped around the high numbers of cattle farmed in and exported from France, and the possible effects of long-distance transport on the animals. All respondents agreed that compared with other species, cattle comprise the highest number of animals transported live to slaughter from France. Although no answer indicated the occurrence of welfare problems before or during the journey, one-third of responses raised awareness

about such issues after transport and highlighted that cattle are subjected to the longest journeys from the origin to the destination country. More than half of the survey participants indicated that data was available for the economic, environmental and social components of the study, and over a third of them trusted that the sector stakeholders would be willing to engage with this part of the project. Regarding destinations, some participants mentioned EU member states. The only third country destination for cattle exports indicated by the surveys was Algeria.

The survey answers were compared with the publicly available data from relevant sources such as the European Commission (EC) Agri-food database (Figure 12), together with other sources (detailed in Appendix 1 and Appendix 2), to reach a conclusion regarding the route's destination.

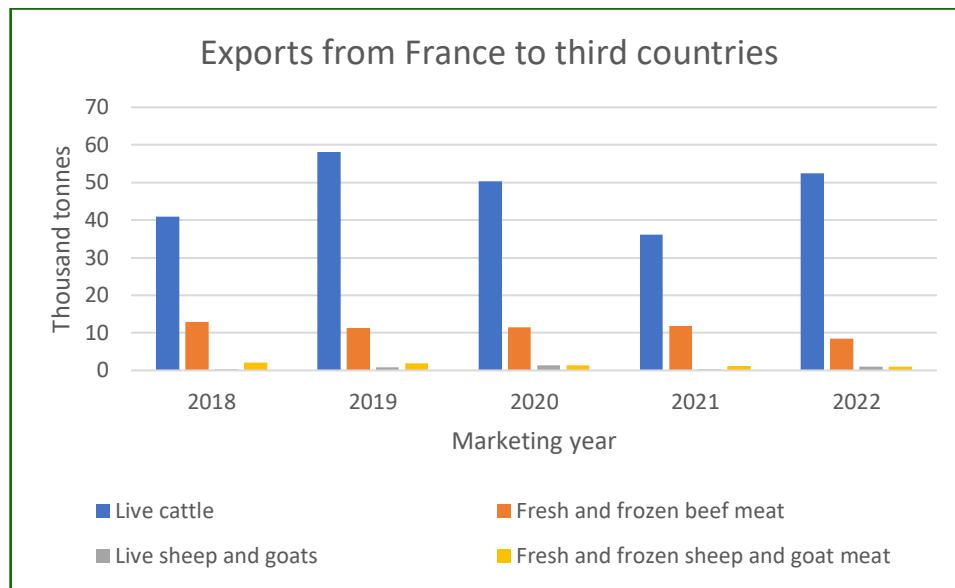


Figure 12. Cattle and sheep and goat (live and meat) exports from France to third countries in the past five years. Source: EC Agri-food data portal (EC-DGARD 2023c, 2023d)

Conclusion: the example case study selected for the carcass meat versus live animal trade from France to non-EU countries, was the movement of cattle to Algeria. The species (cattle) was chosen based on 66% of the survey respondents' selection and on the production data publicly available (see Appendix 1 and Appendix 2). Cattle are France's most exported farm animal species, accounting for 67% of its live animal exports in 2021 (TrendEconomy 2023a) and France accounted for 65% of Algeria's imports of live animals in 2017 (TrendEconomy2023a). Furthermore, on this route (from France to Algeria) cattle are subjected to the longest journey compared with other French destinations and suffer the most compromised welfare.

Spain: survey and desk research results

Reviewing the survey results for Spain, showed that all participants (100%) indicated sheep as focal species for the case study. The detailed answers revealed that even if Spain's most exported farm animal is cattle, most of these animals are brought in from other EU Member States. As this adds layers of complexity to researching the case study, with additional variables such as multiple transport journeys, stressors on the animals, and additional economic costs, it could bias the results, and therefore the cattle trade was not selected for modelling. Other reasons given by the participants for choosing sheep, was the

large number of this species exported by Spain. All of them agreed that sheep represent the highest number of animals transported live to slaughter in/from Spain. Half of the respondents reported the occurrence of welfare problems in sheep both during and after their journeys and, greater welfare problems at slaughter than in other species. The data availability was considered to be easily available by 50% of the survey participants, although none of them believed that the sector stakeholders would engage with this project. The possible destination countries to focus on were Libya, Saudi Arabia, Jordan and Lebanon, and the means of transport recommended was by sea, as Spain has two of the busiest export seaports within the EU. An important piece of information provided by one participant was the fact that most of Spain's live animal exports to third countries are for the production of Halal meat (mentioning that Portugal is the main provider of Kosher meat for Israel) and that Halal-authorized slaughterhouses do exist in Spain and are already working (at low capacity, though).

The survey responses were then compared with the publicly available data from relevant sources (see Appendix 1, Appendix 3 and Appendix 4). Fresh and frozen meat production and transportation to third countries is present in Spain according to the EC Agri-food data (Figure 13), supporting the information provided by the survey.

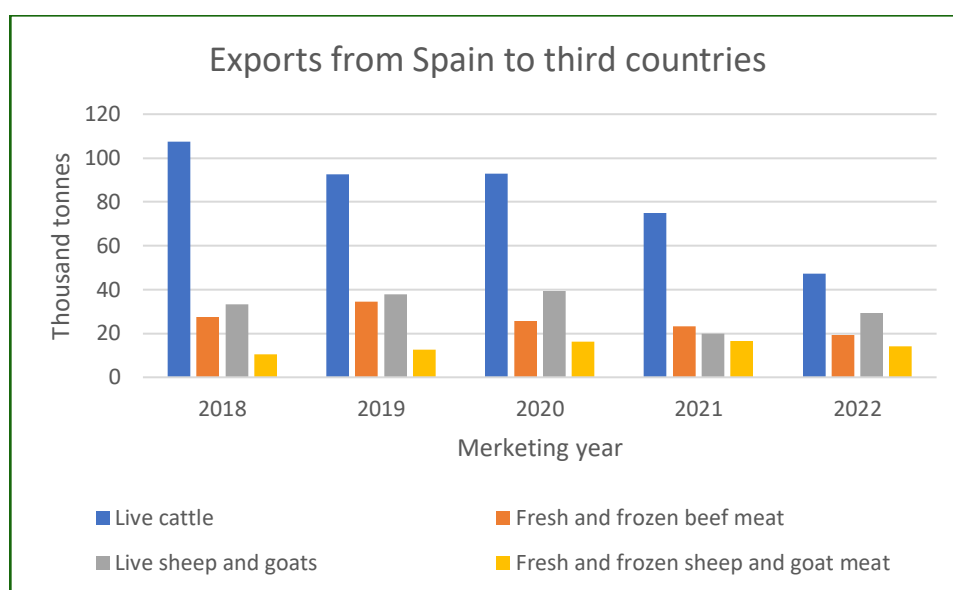


Figure 13. Cattle and sheep and goat (live and meat) exports from Spain to third countries in the past five years. Source: EC Agri-food data portal (EC-DGARD 2023c, 2023d)

Conclusion: the example case study chosen for the carcass versus the live animal trade from Spain to non-EU countries, was the movement of sheep to Saudi Arabia or Jordan. According to public data sources (TrendEconomy 2023b) Saudi Arabia exceeds Jordan in the number of live animal transports from Spain and in a larger percentage of live sheep exports (5.12% vs. 3.41% and 16% vs. 12%, respectively), the difficulty in finding in-country contacts in Saudi Arabia to collect information led to the decision to select Jordan as the case study destination country. Later in the research period this decision changed because the Agriculture Ministry of Jordan decided to suspend the licensing process for importing live sheep and to halt any pending shipments of live sheep, the decision becoming effective since 19 May 2023 until further notice. As alternative route destination to research Lebanon was chosen at that moment.

Portugal: survey and desk research results

More than half (66%) of the survey answers indicated sheep as the species to focus on in the Portuguese context because of the large numbers these animals are exported. Most of the respondents agreed (66.67%) that the welfare issues observed in sheep occur during and after the journeys but all of them agreed that the welfare issues at slaughter are not more severe than of other species. Unfortunately, no respondent believed that the data in this case study would be easily available, nor that the sector stakeholders would be willing to engage with it. Most participants indicated Israel as the destination country for this research because the sheep are subjected to the longest journey from the origin to the destination country by sea. Part of the respondents indicated that Portugal-Israel is the only live sheep transport route, at least to third countries (outside the EU).

The desk research (see Appendix 1 and Appendix 5) completing the survey results showed that the top export destination (59% of all, 200M USD) of live animals leaving Portugal was Israel and sheep and goats represented 22% (74M USD) of it in 2021 (TrendEconomy 2023c). In 2022, Israel imported a total value of 266.24M USD from Portugal, of which sheep and goats accounted for a total value of 88.89M USD (TrendEconomy 2023d). A comparison between the cattle and sheep / goat (live and meat) exports from Portugal to third countries between 2018 and 2022 is shown in Figure 14 and figure 15, it compares the live and carcass trade of sheep between Portugal and third countries in the same time period.

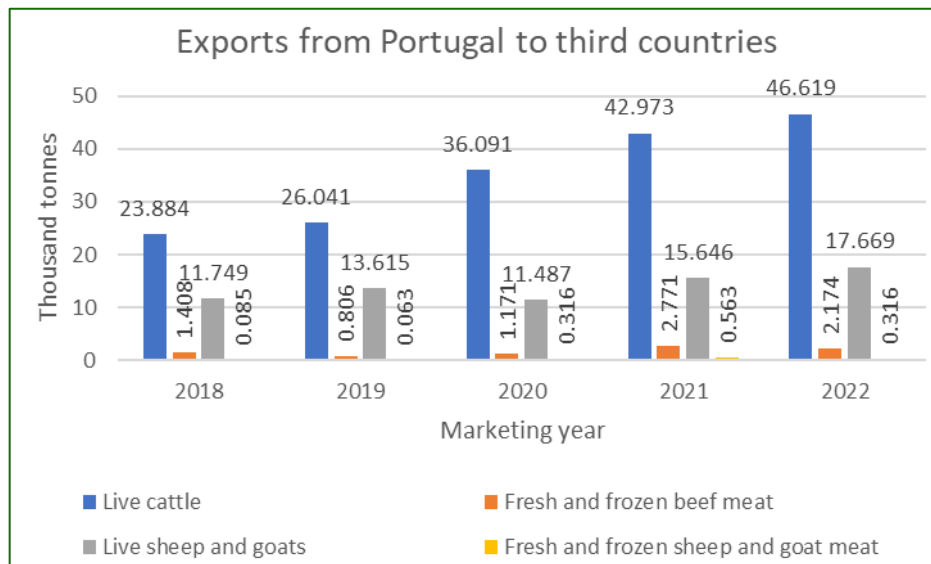


Figure 14. Cattle and sheep and goat (live and meat) exports from Portugal to third countries in the past five years. Source: EC Agri-food data portal (EC-DGARD 2023c, 2023d)

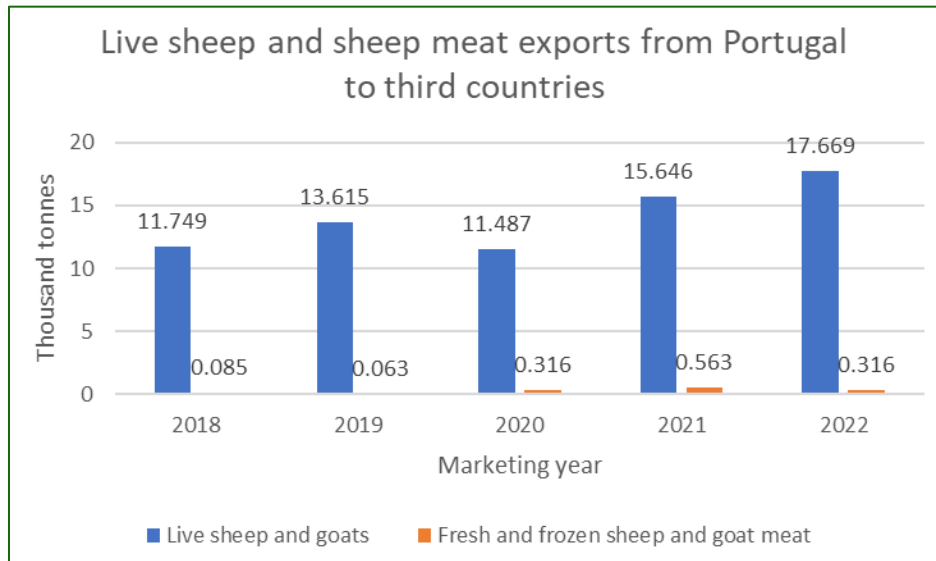


Figure 15. Live sheep and sheep meat exports from Portugal to third countries in the past five years. Source: EC Agri-food data portal (EC-DGARD 2023d)

As the data from the EC Agri-food portal shows (Figure 15), the cattle trade exceeds that of sheep, and the meat trade is significantly lower than the live animal trade from Portugal to the countries outside the EU. According to the Observatory of Economic Complexity (OEC 2023a), in 2021 the country stated at being the 22nd largest bovine meat importer (226M USD worth) and the 34th largest sheep and goat meat importer (21.9M USD worth) in the world (OEC 2023b), sourcing primarily from Spain, but for live sheep imports Israel ranked the 5th largest in the same year (2021, OEC 2023c). The primary source was Portugal, also the fastest growing market in live sheep between 2020 and 2021 for live sheep for Israel was Portugal.

Conclusion: the most appropriate case study for meat vs live animal export from Portugal to non-EU countries was found to be the movement of sheep to Israel based on the combined information gathered from the survey and additional desk research (see Appendix 1 and Appendix 5).

4. Analysis, modelling and mapping: A comparison between the live sheep and carcass trade from Portugal to Israel

This section of the report covers the analysis of the data collected and includes the following:

- 4.1 – Comparative strengths, weaknesses, opportunities and threats (SWOT) analysis covering the different stakeholders involved in the trade from farm to slaughter, comparing the live trade in sheep from Portugal to Israel to the carcass trade. An introduction to this section is included below, with the full analysis being [accessible online here](#).
- 4.2 – Econometric modelling of the costs and environmental impact for the live sheep compared to carcass trade from Portugal to Israel. *Please refer to this document for the explanation of the model, and contact HBCL for more information about the regarding the model.*
- 4.3 – Qualitative exploration of the social impact of live and carcass trade of sheep from Portugal to Israel.
- 4.4 – Systems diagrams ([accessible online here](#)) includes the diagrams and maps generated from the research, analysis and modelling (process and methodology, stakeholder, map of the trade and case study map of the trade).

4.1. Comparative SWOT analysis between the live and carcass trade

The SWOT analysis contains information collected through surveys, online interviews, phone calls and emails, and is underpinned with reviewed scientific and grey literature. It is organised into two scenarios, providing the analysis for each stakeholder involved in the trade in live sheep (Scenario 1) and of sheep carcass meat (Scenario 2).

Regardless of where it takes place, the core of the sheep trade consists of a simple, four-step operation: rearing the meat-producing animal, slaughtering the animal, processing edible products, and selling those products. Yet, depending on the scenario, this four-step operation can become much broader and complex, involving many additional stages and stakeholders at each phase, largely for economic benefits. Additionally, at each step of the process, the existing laws and regulations have to be respected, with regards to taxes, food safety, animal protection and welfare, human and animal biosecurity, environmental protection and consumer rights. The operation becomes even more complex and multilayered when the trade exceeds the borders of a country, a community (the EU), or those of a continent, such as the example of the route between Portugal to Israel.

This research studied the existing practices in different scenarios from the moment the animals leave the farm in which they are bred, up to the point of obtaining the primary product (carcasses). Although rearing the animals is fundamentally important in meat production, the economics of that stage were excluded from the study as a less influential element, because the more steps the whole process has, the less impact the farm of origin has on the price of the final product.

The first scenario (Scenario 1) is based on the existing procedures and practices of the live trade in sheep between Portugal and Israel. To aid clarity, the qualitative data was organized following the steps of the production process, from the farm of origin to the primary post-slaughter processing. After-processing and the final sale of raw or processed meat, were not considered in this evaluation because of the multitude of additional factors and technological processes (in the case of processing to obtain various meat products or ready-to-eat dishes in restaurants) that lie outside the elements of the meat industry considered in this report.

The second scenario (Scenario 2) is based on the existing procedures and practices in the sheep meat trade from several European countries to Israel. Currently, there are only Halal authorized slaughterhouses in Portugal but none with Kosher (Kashrut) certification. Spain is the closest country with abattoir facilities approved by the Jewish authorities to produce Kosher meat, with one such facility for cattle (Frimancha Industrias Carnicas S.A.) and three for sheep (Moralejo Seleccion S.L.U., Moralejo Seleccion and Ramadeira Farras). However, even if country-specific differences are present, for this qualitative SWOT analysis, we have modelled the possibility that Portugal could produce Kosher sheep meat and export it to Israel, namely as if a Portuguese slaughterhouse would be certified for Kosher slaughter and meat production. As with the previous scenario, the analysis is organized around the production stages, and it does not consider the various processed meat products and the final sale of the different products.

The colour coding of the analysis sheet is meant to provide a quick overview of the stages present in both scenarios and bringing the same strengths, weaknesses, opportunities and strengths for the stakeholders irrespective of their location (regardless of them being in Portugal or in Israel), and of the stages which are absent from one of the scenarios. The stages in which the stakeholders have different analysis elements depending on their country of being or on the scenario they are involved in, are described in detail in the separate columns of the sheet.

Please now visit the file [‘4.1. Comparative SWOT analysis between the live and carcass’](#) to view the full SWOT analysis.

4.2. Economic and environmental modelling of the costs for the live sheep compared to carcass trade from Portugal to Israel

The route from Sines, Portugal, to Haifa, Israel, was chosen for this study because it is one of the most popular for the export of live sheep between these two nations. The two scenarios are shown in Figure 16 and are as follows: the first one involves the long-distance transit of live sheep with an average weight of 40 kg that were born and reared in Portugal but fattened in Israel until they reached a live weight of 65 kg before being slaughtered there. In the second scenario, animals weighing 40 kg would be finished in Portugal and slaughtered there when they reached 65 kg, then the carcasses would be shipped to Israel.

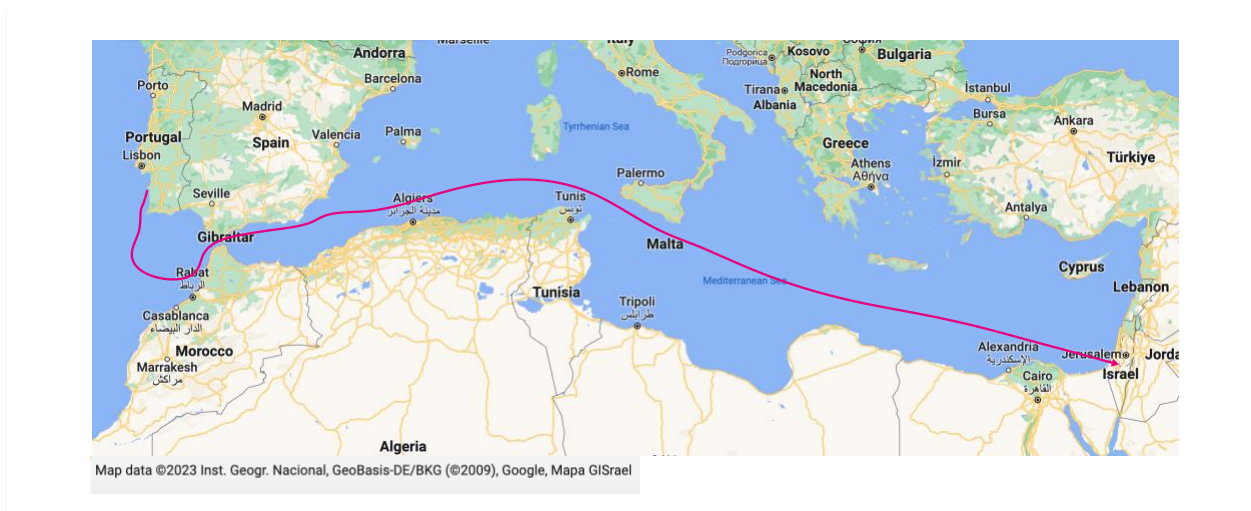


Figure 16. The route from Sines, Portugal, to Haifa, Israel marked by the red line.

Following the modelling approach developed by Baltussen et al. (2017) report in both cases, the model originates at a farm in Portugal and finishes at a meat-processing business in Israel. The start points, end points, and routes would be the same in both cases in order to allow for an accurate comparison between them.

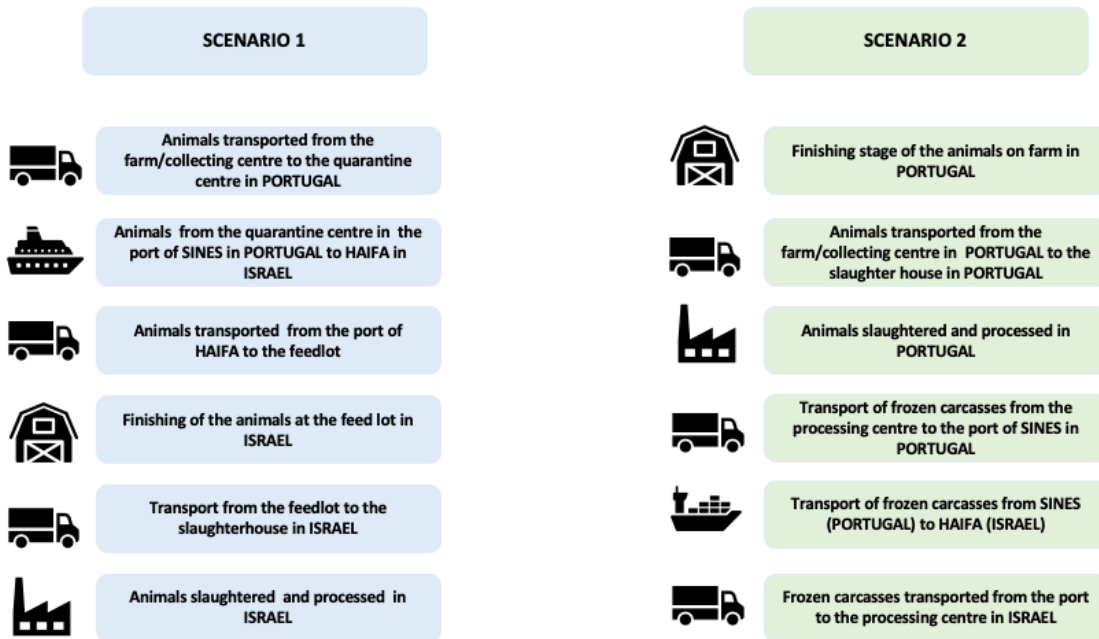


Figure 17. Comparison between the different steps required to export live animals (Scenario 1) versus carcasses (Scenario 2) from Portugal to Israel.

The different costs and environmental effects were calculated using the partial budgeting method similar to Baltussen et al. (2017). This methodology is helpful since it enables comparison of the effects caused by alternative methodologies (Alimi 2000), in this case, the differences between shipping live animals (traditional) versus shipping carcasses on a long-distance trip (alternative).

Model description

The model examines the financial costs and environmental effects of all the many steps required to produce one kilogram of sheep meat that is delivered to the processing facility in Israel.

Microsoft Excel® was used to create the calculating model. Although the structure of the model is deterministic, scroll bars were included to measure the impact of changes in some variables on the outcomes. All the transport or housing conditions of the animals were calculated based on standards for the type of housing/transport and the body weight of the animals.

To calculate the gains and losses in body weight of the animals caused by the different transportations systems, variations in the quarantine and the finishing periods we used a probabilistic approach using random numbers and following a normal distribution. These parameters were extracted from peer reviewed articles (Andronie et al. 2011, Grandin 2014, Padalino et al. 2018, Ronquillo 2018). For scenario 2, the weight of the carcasses was also penalised due to management and transportation (Muñoz 1991).

To present and organise the data with a clear flow, the model was divided into five sections. In the first one, specific data about the scenarios and their components are provided. For instance, the nation and port of departure and the nation and port of arrival, distance between the farm and the quarantine facility and distances between the locations where the animals or carcasses of animals were transported etc. Additionally, the costs per unit for each of the activities such as transport, finishing and slaughter of the animals are given. The mode of transportation (terrestrial or maritime) is addressed in the second section. Using established values from scrolling bars, a variety of variables in this area are listed, such as cargo capacity, the economic value of ship or the total distance travelled in one year.

The third section is the animal modelling component. In this section, the model calculates the different body weight gains or losses and mortalities that occur in the different steps of the two scenarios. The fourth component displays the calculations for each step in the two scenarios. This includes the cost of the different terrestrial and maritime trips including tariffs and health certificates, the finishing expenses of feeding the animals at feedlots and the expenses caused by quarantine and slaughter of the animals. Additionally, in this section the environmental impact for terrestrial and maritime transport are calculated in carbon dioxide equivalents (CO₂e), according to Brander and Davis (2012). The methodology to calculate the CO₂e was adapted from the calculation methods used by Carbon fund (2023). Finally, the fifth section summarises the cost and environmental impacts per kilogram of meat, along with a comparison of mortality rates and weight gain under the two scenarios.

Costs

To calculate the costs both terrestrial and maritime modes of transportation were taken into account. In scenario 1, the animals were transported by land from the farm to the quarantine facility before departure from Sines to Haifa, then from the Haifa port to the feedlot in Israel, and lastly to the slaughterhouse. In the second scenario, the animals had to be transported by land from the farm to the slaughterhouse in Portugal, and then the carcasses had to be transported using temperature-controlled trucks from the

processing facility to a port in Portugal to be shipped to Israel and then from the port in Israel to the marketing/processing facility (Figure 17).

Regarding the maritime transport in the first scenario, the live animals were moved in specific livestock transport vessels. Cargo capacity, surface area for the animals, feed and water provisions, duration of the trip and crew among other variables were included. For the second scenario, frozen carcasses were transported in 20-foot temperature-controlled containers in a cargo ship. Following the Baltussen model (Baltussen et al. 2017), in both terrestrial and maritime transport charges associated with transportation were included such as any toll charges (for terrestrial), fuel, drivers or crew wages, cleaning and disinfection duration, depreciation, maintenance, and interest on the trucks, as well as costs associated with weight losses and mortality of the animals due to transport.

For the finishing costs of the animals, identical conditions were assumed in Portugal in scenario 2 as in Israel for scenario 1. It was assumed that the animals were finished under confinement conditions in a feedlot starting at 40 kg and finishing at 65 kg, with an average daily weight gain of 300 grams and fed a total mixed ration with a conversion rate of 6:1. Costs included in this cycle were feed, health, maintenance, cleaning and disinfection, and interests following the cost structure of the lamb finishing cost of production calculator (O'Brian and Molenhuis 2023). Quarantine costs were also considered in a similar fashion to the finishing process. Finally, slaughter costs were included and were calculated for both countries, however, to facilitate the process it was assumed that the slaughter occurred under equal quality and hygiene conditions.

The overall costs in a situation were determined using the equation shown below:

$$C = \sum F + T + N + S$$

Where:

C = Total costs

F = Finishing costs. Fattening the animals from 40 kgs to 65 kgs on average. Includes feed, health, maintenance, cleaning and disinfection, and interests.

T = Terrestrial transport. This includes the truck's depreciation, maintenance, and interest charges as well as fuel costs, driver salary and tolls.

N = Maritime transport. This includes tariffs and health certificates, quarantine costs the ship's depreciation, maintenance, interest charges, fuel costs, crew costs, feed, and maintenance cost of the animals during the trip.

S = Slaughter and processing costs.

Other components

Each of the components of the two considered scenarios posed challenges for the welfare of the animals, including weight loss and mortality during terrestrial transport, or mortality, weight loss/gain during the finishing cycle, the quarantine and maritime transport. For the environmental aspects, the emissions of CO₂e were calculated for the terrestrial and maritime transports, differentiating if there were

requirements of temperature-controlled vehicles and containers because to keep the temperature low, the engines require a higher consumption of fuel.

Data collection

To feed the model, data were gathered from a large number of varied sources. Telephone interviews were conducted, and e-mail questionnaires sent to relevant stakeholders from Israel and Portugal were conducted. In addition, the researchers input information collected from relevant studies and peer reviewed papers (listed in the references section of the model). Finally, publicly available data accessible on the web for specific topics such as truck and vessels descriptions were used.

Using the Baltussen et al. (2017) model, the following assumptions were made when creating the model:

1. It was assumed that both the trucks and vessels were owned rather than rented.
2. When transporting chilled or frozen meat, we presupposed no degradation of meat quality, but we penalized a loss of 4% (Muñoz 1991) in the carcass weight due to management and processing.
3. We assumed that there would be no differences in the body weight gain in the animals finished in Portugal or Israel.
4. Both nations were assumed to employ the same type of slaughterhouse. This indicates that the work efficiency (labour input) for slaughtering is the same in both cases.

Table 3. Comparison between transport of live animals (scenario1), versus meat carcasses (scenario 2) from Portugal to Israel.

Indicators	Unit	Scenario 1	Scenario 2	Difference
Detail of some of the most important costs				
Finishing costs*	€ per kg of meat	0.43	0.43	0.00
Terrestrial transport costs	€ per kg of meat	0.08	0.04	0.03
Maritime costs	€ per kg of meat	2.00	0.02	1.97
Slaughter costs	€ per kg of meat	1.43	1.15	0.28
Total costs	Cost of one kilogram of meat transported to Israel	3.94	1.65	2.29
Welfare Indicators				
Mortality	%	1.29%	1.02%	0.27%
Weight gain/day**	kg/day	0.244	0.277	-0.0328
Days to reach slaughter weight	days	94	85.06	8.94
Environment Indicators				
CO2 Eq	gr per kg of meat	1559.65	279.71	1279.94
Diesel Use	l per kg of meat	0.52	0.08	0.44

* Finishing costs: the costs related to fattening the animals from 40 kg to 65 kg (slaughter weight)

** Weight gain per day: the difference between the slaughter weight and the initial weight divided by the total number of days from the initial weight until the slaughter

Analysis

The economic difference between the two scenarios was €2.29 per kg of meat in favour of the second scenario. This means that the cost of transporting one kg of meat from Portugal to Israel was 41.8% lower than the cost of transporting one kg of meat as live animals. In the first scenario, the cargo capacity was limited by the livestock transport surface area. For instance, Ganado Express a livestock cargo vessel that often moves animals between Sines and Haifa has an area of 4,500 m² distributed in five decks to house the animals. In this area it is possible to accommodate 22,500 animals of 40 kg each (5 animals per m²), which in total represents 900 tonnes of body weight or approximately 248 tonnes of meat. In the second scenario, if we use a cargo ship to transport frozen carcasses, an average cargo vessel can transport up to 1802 20-foot temperature-controlled containers. Each of these containers can transport up to 19 tonnes of meat, however it is important to consider the total cargo capacity of the vessel. In the modelled case 16.5 tonnes of meat per container is the maximum container capacity to not overload the vessel. Therefore, the cargo capacity is approximately 30,000 tonnes, which in this case are frozen carcasses or 15,000 tonnes of meat after penalising 4% of the weight for freezing and handling. In other words, it is possible to transport almost 60 times more meat in the form of frozen carcasses in comparison to the transport of live animals.

From the animal welfare aspect, the second scenario is more favourable to the animals. In the second scenario the mortality due to transport is lower because the animals are only moved once from the farm to the slaughterhouse in Portugal, in contrast with the first scenario where the animals need to be moved four times including the maritime transport. Also, the gain of body weight is faster in the second scenario, because even if assuming that the conditions of finishing the animals (mortality, conversion) in both countries are similar, the transport of the animals and the quarantine causes weight losses and increase the time needed to reach the ideal body weight for slaughter up to 9.5%. Also, the overall gain of weight per day is decreased by roughly 19%, assuming that the expected daily gain is of 300 grammes.

Regarding the effect on the environment, two factors were taken into account. The first one is CO₂e. The impact of various greenhouse gases on the climate is standardized using this unit. As observed in Table 3, the CO₂e of scenario one is almost six times bigger compared to scenario two. Although the emissions of the cargo vessel were three times higher than of the livestock vessel because of the size of the ship and extra emissions caused by the temperature controlled containers, the possibility to increase the transported quantities level the emissions per kilogram of meat.

The second aspect considered to evaluate the impact on the environment was the fuel consumption. Similar to the emissions of CO₂e, the consumption of fuel in the first scenario is more than six times higher compared with the second scenario, for similar reasons as described above. Even with a higher total consumption of fuel in the second scenario (because of the need for temperature-controlled trucks and containers), when the calculation is made per kilogram of meat, the results favour the second scenario.

Please now refer to the Excel file 'Economic and Environmental Model' to access the model.

A detailed excerpt of the model can be found in Appendix 5.

4.3. Qualitative exploration of the social impact of live and carcass trade of sheep from Portugal to Israel

A consideration of the community is an important part of every business and for this study researching the social implications associated with the live and carcass trades was paramount due to the nature of the topic. Buying and selling are ancient human activities and the availability of the food items being traded, has deep-rooted survival connotations for us, even when we consciously may not realise it. Although we have focussed on the central question of this study, it is impossible not to address the human community, which is simultaneously the background, the engine and the target, of the industry we look at.

Is the meat trade better than that of live animals? From the social point of view, both trades are performed by people, providing for people (food, workplaces, salaries, knowledge, freedom of choice and so on) while impacting people in positive and negative ways, directly and indirectly.

A historical perspective

It is a stark reality that food is essential for survival and is not fairly distributed around the world, or between communities. As such, certain dietary items have gained differing significance throughout history, the food people can access or afford is often a status symbol, with heightened importance compared with other foods. Possibly the most prominent example of a food that is perceived in this way is meat. Acquisition of meat once proved physical strength, speed and skill in hunting, later the ability to pay for the best cuts was the 'right' of somehow privileged people in high social positions. Meat has long been considered to be nutritious and has been reserved in historically hard times (e.g., during wars) for men to sustain their strength, for children to improve their development, and also for the elderly as a sign of respect, consideration and care. These kinds of embedded perceptions are likely to unconsciously influence us even today, and even though the true importance of meat in our diet is debated whether relating to the scientific research, or to the traditions, religions and rituals that form part of our identity.

The activities rooted in producing the meat our societies consume (from basic agriculture, through developed transport means and to sophisticated processing technologies) impact all of us in several interconnected ways, intertwining the social aspects with the economic and environmental facets. Even though situated on different continents, Portugal and Israel have had diplomatic relations for a long time. The State of Israel has been represented in Lisbon since 1959 by a Consulate-General, which had always functioned without interruption (Futscher Pereira 1977). Much more recently (1924), Portugal and Israel signed an inter-governmental Memorandum of Understanding in which both countries agreed to execute a cooperation program (science and technology) aimed at strengthening relations between Portugal and Israel to foster long-term scientific cooperation (Fundacao para e Ciencia e a Tecnologia 2022). According to Portuguese Ambassador Jorge Cabral, Israel has the largest Portuguese diaspora in the Middle East (Cashman 2022).

Even more suggestive of the two countries' ties is the fact that in 2013, Portugal became the second country after Israel with a Jewish law of return, after 500 years of expulsion (Liphshiz 2013). After the law's enforcement in 2015, more Israelis sought Portuguese citizenship than any other foreign group, reaching 20,975 applications in 2022, well exceeding the number of applicants from Brazil (Portuguese Immigration and Border Service's statistics cited by Bartov 2023) whose population is 20 times larger than Israel's and has longstanding cultural ties to Portugal, including a shared language. Even if most of the

Israelis who applied have not moved to Portugal and may be driven by the 'desire for a plan B', Bartov (2023) mentions that among the possible motivations of the applicants, are the lower taxes in Portugal and lower living costs compared with Israel. This reality was also revealed in our study, at a simple market search this summer (2023): the price of sheep meat (sliced and packaged) was around € 9-11/kg in Portugal and € 46/kg in Israel (Kosher labelled ribs that contain the bone too, and the same product's non-Kosher version was € 44/kg). According to another source (Cohen 2023), as of the spring of 2023, of the 56,000 Israelis receiving Portuguese citizenship, 15,000 were already living in Portugal. One of the reasons given was that the Portuguese government provides state support for small, traditional farming businesses (Arad 2023), which explains the preference of Israeli farmers to continue their traditional animal husbandry practices in Portugal.

New commercial trends

Most Portuguese farms are small- to medium-sized family businesses and for sheep rearing they prefer extensive husbandry systems, based on grazing. Many of these facilities have overall numbers of fewer than 50 animals, traditionally of several species (cattle, sheep, equines, poultry). Around 52,000 farms contain close to 2.2 million sheep in Portugal (Tiberio & Diniz 2014, TrendEconomy 2023e) representing the country's main breeding stock. Although this sheep population could be used to ensure the country's self-sufficiency regarding the main products demanded by the internal market (meat and meat-based food products, milk and dairy products), Portugal started to export live sheep to third countries, mainly to Israel and Palestine from September 2015 (Correia 2022). The trade has continued and has affected and sculptured the social structure of the country. When asked, one of the Portuguese farmers interviewed for this study (2023) shared his opinion on the subject:

"Other farmers, they put the animals on the boat, they export everything. I know something about it. This started maybe three-four years ago, and it is killing all our market, because our small chains of meat processing are completely out of the game. This big flow of meat... and... yes, I never sold any animals to these... Many others do, they export three-month-old lambs. They never sell directly to the boat owner, and they have people in Portugal, landowners, that hang the animals. It is a chain. Not direct. There are parks, some people privately have these parks, then they use the parks to concentrate the animals, and whenever they have enough for export, for a boat, they charge it. They [the park owners] make the small business here, but these guys are working with the bigger ones. But it is never direct, to the boat from the farm. Normally these people are in the business for a long time..."

In Portuguese terms, this respondent has a large farm of around 130 sheep, 80 cattle, horses and donkeys and poultry. He was proud of his role in Portugal's 'well-being'; he described that by raising traditional rustic animal breeds his farm contributes to gene preservation and by small-scale rational grazing they contribute to the ecosystem's regeneration. To make a better living and thrive in the changing social and agricultural system, this farmer developed a small production line to sell the traditional meat, milk and egg-based products locally - packaged and labelled according to the EU and national Portuguese legislation in force. Formerly part of a cooperative, which is still a common and powerful agricultural structure in Portugal, now as a family business, the only service our interview subject had to externalize was the slaughtering of the animals. The transport of the live animals to the slaughterhouse (100 km away) and the carcass transport back to the farm for processing caused him weekly expenses (€ 300). However, the farmer highlighted that he had a significant advantage over his peers because he had inherited the land for his farm from his family and uses it mainly free of charge (except for the state taxes).

The unavailability of land (the need to purchase or rent land to set up and maintain a farming business) is a powerful limiting factor for young entrepreneurs when they decide whether to engage in agricultural activities (Eistrup et al. 2019). Those farmers who do not need to purchase land can broaden their activity in Portugal by investing in equipment to process their products. Moreover, the cooperative system provides the benefit of the shared participation of several farmers to build a common business and share its profits. For some farmers, without resources and/or considerable help from governmental or European entities, being part of the developing chain of live sheep exports from Portugal seems to be another valid option. The creation of the live sheep export business and infrastructure (e.g., the collection centres) has provided a market to which the Portuguese farmers can sell their lambs.

Farmers sell their lambs to collection centres, which in turn sell the animals to the live animal transporter. One of our organization-affiliated interviewees (2023) told us that one of the biggest livestock producers has a 42,000-acre facility (collection centre, which might simultaneously function as a quarantine farm) with 85 “parks” for bulls (calves) and four for sheep (lambs), employing 65 people. In other cases, the collection centre is owned by the importer company itself. A public advert for sheep handling devices (Te Pari, Johnson 2021) describes a sheep finishing farm (feedlot) in Portugal that exports 40,000 to 50,000 lambs per year to Israel. According to the facility manager, the farm’s capacity is of 20,000 sheep. They receive lambs almost daily and they are able to export 12,000 sheep in a single day, once they gathered the sufficient number of animals. This centre is owned by the Israeli De Levie company, one of Israel’s prominent sheep producers.

As well as the export market, Portugal has an internal market for sheep meat. As the publicly available data (Statista 2023) shows, the small ruminant meat consumption per capita in 2022 in Portugal was 2.3 kg/year. With a population of 10,343,066 counted in 2021 (Portuguese National Statistics Institute 2022, estimated to be over 10.3 million in 2022 by Macrotrends 2023) the overall small ruminant meat consumption was around 23,790 tonnes, almost 24,000 tonnes per year (23.6 tonnes by calculation for the Macrotrend estimated population). This demand exceeded the amount that could be produced in Portugal. In 2022, the domestic production of sheep and goat meat was only around 10,000,000 tonnes in Portugal (Eurostat data cited by TrendEconomy 2023f), covering only 42.44% of the country’s domestic demands. According to the EC-DGARD Agridata portal (2023f) the production could have been higher, 15,000 tonnes (decreasing from 16,000 tonnes in 2020 and 17,000 tonnes in 2021), but it still barely covered half of the in-country consumption. Despite its internal market demand, Portugal became the main live sheep provider of Israel. In the past few years, the live sheep transports increased (product weight to nearly 11,000 tonnes in 2020, over 13,000 tonnes in 2021 and over 15,000 tonnes in 2022, EC-DGARD 2023g).

According to the Observatory of Economic Complexity (OEC 2023d, 2023e), Portugal participates actively in the sheep and goat live and carcass trade through both exports and imports. For example, in 2021 besides Israel, Portugal was exporting live sheep to Palestine, Spain, France and the Netherlands, totalling an income of \$ 77.2 million (€ 65.3 million) for Portugal. Sheep and goat meat exports were added to the shipments of live animals, bringing an additional \$ 6.79 million (€ 5.74 million) revenue. In order to sustain the business, in 2021 Portugal became the 15th largest importer of live sheep and goats in the world (primarily from Spain, France, the Netherlands and Belgium) spending a total amount of \$ 24.1 million (€ 20.38 million). Additionally, in the same year, they paid \$ 63.6 million (€ 53.79 million) for sheep and goat meat imports (OEC 2023d, 2023e). In 2021 Portugal gained \$ 83.99 million (€ 75,26 million) by sheep and

goat (live and carcass) exports and spent \$ 87.7 million (€ 74,98 million) for sheep and goat (live and carcass) imports, realizing a hardly significant profit of € 301,000.

No public information is available regarding whether any of the animals imported alive continued their journey towards another country (in live shipment or as carcasses) nor whether the imported meat was consumed within Portugal or sold on further. However, the Portuguese establishments database (Sistema de Informacao do Plano de Aprovacao e Controlo dos Estabelecimentos – SIPACE 2023) reports 43 approved and registered slaughterhouses for sheep in Portugal (2023), which slaughtered around 698,000 sheep for consumption in 2022. The origin of the slaughtered animals was probably both from internal production and from imports. Considering the optimal live-weight-to-carcass conversion efficiency and thus assuming that these sheep were slaughtered at 65 kg each, their total weight could have reached over 45,000 tonnes yielding around 22.68 tonnes of carcass weight. In the absence of exports, the internal production summed with the imports would have been enough for the Portuguese nation's sheep meat demand, but part of it was exported, primarily to France, Egypt, Italy, Spain and Oman (OEC 2023f).

The societal impact of slaughterhouses

It is difficult to find information regarding the employees working in the Portuguese slaughterhouses and the numbers available are inconsistent. Viegas et al. (2016) reports 189 workers for a swine and bovine slaughterhouse with a capacity of 150 tonnes of animals per day, but only 31 workers for another large animal slaughterhouse with a similar capacity (280 large animals per day). However, according to our organization-affiliated interviewee (2023), the Portuguese abattoirs are currently working to one third of their capacity and these could bring economic value to the country. Another aspect adding perspective, is the fact that some of these slaughterhouses have Halal authorisation and produce meat that is Halal-certified by the Halal Institute of Portugal (Instituto Halal de Portugal 2015). In order to fully enable the sheep carcass trade toward Israel, Portugal should obtain Israeli governmental authorization for at least one slaughterhouse (Kosher or Kashrut certification) and periodically have a Kosher slaughter team in the approved facility. This is an example of a similar situation already in place in Spain, where three cattle and one sheep slaughterhouse operate in this way. The opportunity is open, as Israel cannot self-sufficiently cover its population's sheep meat demand and the economic efficiency of live animal imports is unclear.

A short socio-economic background was provided by one of our Israeli collaborators (2023).

“About Israel. Roughly 73% [of the population] are Jewish, 21% Arabs (including Muslims, Christians and others) and 6% others. Out of the Jewish about 70% eat Kosher, but only very few want Israeli slaughter. They count on the rabbis who do the slaughtering overseas. Among the Muslim Arabs, 89% eat Halal [...]. It is relatively common among the Arabs to do a home slaughter which is fresh. I cannot tell if it is for religious reasons or just tradition. The biggest question is how many animals Israel can raise here, not overseas. Probably that can cover all the “need” of people for fresh meat. The non-Kosher parts are cheaper and sold to people who don't care for Kosher and non-Jewish.”

Unfortunately, the available data proved that Israel's internal sheep production cannot cover the population's meat demand. Another Israeli contact of ours (2023) estimated that “[...] today Israel... many farms closed and now the local production covers about 60-65% of consumption. Having said that, there is the problem of unauthorized slaughter [...]. There have been estimations that over 70% of the slaughter in sheep is unauthorized. And there is no traceability.” A governmental publication overviewing the Israeli

sheep industry includes financial data on the "*black slaughter*" (unauthorized slaughter word-by-word translation from Hebrew).

The approximately 2,400 Israeli small ruminant farmers keep around 430,000 sheep (Leibovich 2021), mostly the breeding stock of the country. With a population of slightly over nine million (9,038,309, Macrotrends 2023) and a sheep meat consumption of 1.54 kg/capita/year (OECD-FAO 2023) the Israeli population consumed close to 14,000 tonnes of sheep meat (13,918,996 kg) in 2022. By using the approximate lambing percentage for small flocks (65%, Leibovich 2023) and assuming that the breeding stock would have around 400,000 ewes, the yearly lamb production in Israel could be around 260,000 lambs. At the slaughtering weight of 65 kg each (to obtain the optimal live to carcass weight ratio) the internal lamb production would yield over 8,000 tonnes of carcasses, making Israel's sheep meat production insufficient to cover the domestic market demand.

Consequently, Israel imports both live sheep and meat. The amount of sheep meat (fresh, frozen and edible offal) imported in 2022 to Israel from the EU was almost 2,000 tonnes (1,932,000 kg, according to the EC Agridata portal 2023). As per the OEC (2023) data, in 2021 Israel ranked the 34th largest importer of sheep and goat meat in the world, importing primarily from Spain, France, Australia, Argentina and Chile, and spending a total amount of \$ 21.9 million (€ 18.52 million) for these purchases. The only countries to which Israel exported sheep and goat meat in the same year were Palestine and Seychelles (\$ 796,000 or € 673,000). The figures are much higher for the live sheep imports and relatively congruent. One of our interview subjects mentioned 380,000 live sheep imported in 2022, which would total just over 15,000 tonnes of live weight at their entry in the country (assuming that the lambs arrive at around 40 kg each), and the EC Agridata portal (EC-DGARD 2023d) lists over 15,000 tonnes for the same year. According to the OEC (2023c) statistics, Israel was listed as the 5th largest live sheep importers in the world, spending \$ 83.9 million (€ 70.96 million) for the purchases, primarily from Portugal (\$ 62.8 million or € 53.12 million) and for much lower amounts from Australia, Serbia, Hungary and Romania.

The Israeli Veterinary Services Report (2022) states that in 2022 the 11 Israeli abattoirs slaughtered 333,465 sheep (by calculation producing nearly 11,000 tonnes carcass weight), but it is not mentioned if the animals were produced inside the country or imported. The carcass weight obtained in the slaughterhouses added to the almost 2,000 tonnes of imported meat (nearly 13,000 tonnes) almost satisfy Israel's internal market demand in 2022 (nearly 14,000 tonnes), suggesting that for the domestic production of lambs, unregulated slaughter may be a reality.

The number of slaughterhouse employees is difficult to find and verify. A newspaper article (Lior 2013) reported that the slaughterhouse Adom Adom, employed 200 workers from the Bet She'an area. As there was no more information on the number of employees in Israeli slaughterhouses available, information from other countries can be extrapolated for comparison. For instance, the website of Australia abattoirs (2023) summarises the output and workforce of some slaughterhouses and states that an abattoir processing up to 2,500 small stock animals per day (including sheep) employs 70 people. However, this example is not a Kosher-certified slaughterhouse. According to Greenwood (2022), approximately 600 Kosher slaughterers work in Israel and periodically abroad to perform ritualistic slaughter for the meat to be approved as Kosher and permissible for the religious Jewish community to consume. Non-Kosher meat cannot be imported in Israel, thus the work of the teams (between nine and 15 butchers and assistants with a team leader) sent abroad (usually for three to four months, twice a year) is important for Israeli meat consumers. The support from the Israeli government in favour of carcass trade (as opposed to that

of live animals) is shown by the total absence of custom tariffs for beef carcasses and a tax-free quota for each importer when they bring sheep (and goat) meat into the country (Israel Tax Authority, Customs 2023).

From the social point of view, these data show that both Portugal and Israel have a considerable social structure involved in both the live sheep and sheep meat trading and both versions of the trade are already in place bidirectionally (imports and exports) to a certain extent. The only missing scenario in regard to the country pair is the absence of the carcass trade from Portugal to Israel. If that were to be introduced, surely it would bring changes regarding the complex implications in the social area and outside of it (economic and environmental aspects, at least). More details can be found in Appendix 7.

Considerations regarding a change from transporting live animals to carcasses

As the data gathered and analysed in the present study show, two social elements must be considered when modelling a change from the live to the carcass trade of sheep from Portugal to Israel. One is related to procedures involved in producing and selling a type of meat that is accepted by the consumer (namely Portugal should be able to produce Kosher meat besides the already existing Halal certified meat production), and the other regards the dynamics of the workplaces during a transition from the live to the carcass trade of sheep and after the carcass trade would be implemented.

Analysing and interpreting the workplace dynamics must always take into account the inherent characteristics and specificities of each country (or even region) included and this kind of modelling cannot be extrapolated in the 'one size fits all' manner to different country pairs or situations.

In our study, both countries (Israel and Portugal) have a certain amount of internal sheep production, without reaching self-sufficiency (to cover the in-country sheep meat market demand). As a result, the farming sector is not at risk of losing activity or income, rather the opposite. By having information about the market trends and by using the already traditionally established cooperative system in Portugal, sheep farmers could schedule their lamb productions to meet both the internal market demand and the carcass export needs, because both the sheep production and the market demand has a certain seasonality (the lambing seasons could be modulated according to the time periods of the year when the market demand is higher because of specific holidays). Israel could use its in-country production to make available fresh and/or chilled meat for the Israeli population, and thus the farmers could have higher benefits.

The road transport system, both for live animals and carcasses over short distances (from the farms to the slaughterhouse, or the temperature-controlled truck transporters between the slaughterhouses and port) would have to continue their activity.

One of the elements in the meat chain that would have to adapt is the slaughterhouses. In Portugal, these would have to increase their workload, but as these facilities work at one third of their capacity, they would be able to adapt. On one hand, to continue to provide meat for the Jewish community (in Israel or elsewhere), the Portuguese slaughterhouses would need Kosher certification and collaboration with Israeli slaughterers. On the other hand, the workload of the Israeli slaughterhouses could lower, at least at the beginning of the transition period. An important problem to tackle in Israel is that of the unauthorized sheep slaughter. The high retail prices of sheep meat (around four times higher than the similar cuts in the Portuguese shops) clearly provide a consumer motivation to buy meat originating from the 'black market'. Although there is no publicly available evidence of negative effects, the consumption

of meat that is not verified (by veterinary professionals) can have dramatic health consequences for the consumer. Diseases such as leptospirosis, bovine tuberculosis and brucellosis are highlighted in the Report of the Veterinary Services Report of the Ministry of Agriculture and Rural Development of Israel (Blaish 2022). Among others, these have a high zoonotic potential with severe health impact once contracted by humans. These and other diseases (including avian influenza, foot and mouth disease and bluetongue) can also be transmitted to susceptible animals by human vectors on their clothes, hands or by the waste of processing products from infected animals. The risks that meat and meat products may carry these harmful pathogens increase when the meat is not verified by an appropriate professional. Once the carcass trade is in place, the shorter chain would remove several additional layers of the chain and this way the lowered production costs should be reflected by the lowering of the final product's price. Consequently, the Israeli consumer could more easily avoid the unsafe meat buying situations.

Another element of the chain that would need adapting in the transition process from live sheep to carcass trade are the quarantine farms, which would be rendered unnecessary if the slaughter would take place in the country of origin. As most data in this study showed, the quarantine farms are often coupled with feedlots for economic reasons (in the compulsory eight-day quarantine in Portugal and Israel not many possibilities exist for considerable incomes). Even if the quarantine facilities would disappear, besides the possibility to repurpose them in other industrial locations, the feedlots would be still necessary. For medium and large slaughterhouses, it is more profitable to work at their normal high capacity, than to start the production lines for small numbers of animals. The national characteristic of farming systems in both countries is based on small to medium farms, with small breeding stocks and even smaller lamb productions, which are seasonal. Several farmers would need to work together to be able to provide such lots that allow a good productivity on the slaughter line and most probably feedlots would be operated in a way that would ease this process. In Portugal, the feedlots could be managed by cooperatives and depending on the structures in Israel, the same approach could be taken (or third-party entrepreneurs could provide this role).

The maritime transportation would change too, as the container transport is much more economical in terms of space, and easier to manage. Some of the developed industry stakeholders' own livestock transport vessels, some of which are old, modified cargo-ships. In the maritime transport world, such carriers are considered the most dangerous ones and some of them are hardly re-authorized because of structural deficiencies (de Bois, 2021). For the outdated and retired vessels, alternative purposes can be found (re-purposing them or parts of them, recycling or scrapping, preparation for use as artificial reefs and disposal on land, as advised by the US Environmental Protection Agency), if they cannot be used anymore as cargo ships to continue to provide incomes to their owners.

In summary, the quarantine facilities are the only structure in the current sheep trade from Portugal to Israel that would be completely 'sacrificed' by the change from the live to the carcass transportation, but the real reduction of workplaces caused by their disappearance is not clear because these facilities could be transformed in feedlots. The adaptability of the social structures involved on the Portuguese side has already been proven, as the live trade of sheep is new in this country (beginning in 2015). The analysis performed within this project and outlined in this report has the advantage of not only researching the elements of the existing industry chain but also revealing the interconnections between them in a larger-scale overview. This approach can aid finding the solutions for the elements subjected to change (by recognizing economic and social opportunities) and also considering the impact of continuing the existent practices.

The identified negative trends that would continue in Portugal if no sheep trading change is implemented, include: economically unjustified import-export loops, endangerment of the traditional national farming structure, encouragement of large-scale enterprises with high environmental impact, economically sub-efficient facilities (the slaughterhouses), high risk of welfare issues in large numbers of animals (transported alive) and continued lack of production self-sufficiency.

For Israel, the most visible inefficiencies of the current trade practices that would continue include: marginalisation of the national farming businesses, unjustifiably high retail prices that stress the household economies and endanger the health of consumers when they resort to meat produced by unauthorised slaughter, indirect participation to the poor welfare situation of large numbers of animals (imported alive, subjected to forced adaptation and metabolic stress for rapid weight gain, at least), fodder wastage (to feed the imported animals to regain their pre-transport weight), increasing monopoly of big investors to own and take profit from the entire industry chains, while repressing the growth opportunity of smaller-scale operators, and unnecessary environmental impact inside the country (e.g. emissions of the animals brought alive to be fattened in Israel).

The ultimate aim of any change adopted should be to limit the negative effects of current practices and those brought by the change itself, while maximising the existing positive element and leveraging the positive consequences of the change.

4.4. Systems diagrams

Systems diagrams ([accessible online in the file named '4.4. Systems Diagrams'](#)) includes the diagrams and maps generated from the research, analysis and modelling (process and methodology, stakeholder, map of the trade and case study map of the trade).

5. Discussion: creating a business case for change

Ambitious and needed project

This ambitious and innovative project set out with the aim of building a business case for a change to the export of carcasses instead of live animals from the EU to third countries. It aimed to explore the economic, environmental, and social benefits, as well as the possible downfalls that change could bring. It is intended that the results and recommendations may be utilised to engage stakeholders from across all elements of the sector, including policy makers, to drive positive change. This could include demonstrating the benefits of change for the agricultural sector, the consumer, wider society, the planet and, at the centre of this, the animals involved.

In short, this ground-breaking project has made a case for change through looking at examples of the trade between the EU and third countries – namely, there is evidence that a carcass trade is more cost-effective, less harmful to the environment and practically feasible at a social level, than a live trade in animals for slaughter.

Carcass trade – cost saving economically and environmentally

The review of the literature, extensive research, analysis, mapping, modelling and discussion of the trade and case example, have shown that the live trade in animals for slaughter is resulting in a significant financial loss for those involved, when compared with the carcass trade. The culmination of this research shows that the live trade in animals is almost 2.5 times (2.387 times) more expensive per kilo than the carcass trade (live = €3.94/kg versus carcass = €1.65/kg, a difference of €2.29/kg), or framed differently, it is almost 2.5 times more costly to export live animals per kilo than carcasses. As a result, the overheads and costs associated with the live trade are resulting in additional expenditure, and therefore a lower overall income than the carcass trade.



This research shows that it is nearly 2.5 times more costly to export live animals per kilo than carcasses.

The costs and overheads also link to the time required for weight gain and finishing the animal ready for slaughter. For the case study of Portugal to Israel, the live trade was shown to take around 9 days longer (8.94 days) to get ready than the carcass trade. This extra time attracts additional expenditure use of resources, and therefore impacts upon income and the wider environment.

When looking at the environmental impact of greenhouse gases, the CO₂ equivalent emissions (CO₂e) for the live trade are nearly six times greater than for the carcass trade per kilo of meat. Fuel consumption is almost seven times higher for the live trade compared with the carcass trade. While the requirement of temperature-controlled containers results in greater emissions, the inefficiencies of the live trade cancel this out – put simply, the live trade cannot transport the same quantity of meat per journey as the carcass trade. The specificity of the transport adds to this aspect: besides the possibility to tailor the meat

quantity, the carcass trade allows shipping of selected cuts as well, to closely fit the market demand. The importance of this aspect is considerable in our case example, as certain parts of the carcasses (the sciatic nerve area and consequently the animals' hindquarters) are not considered Kosher. Rather than the importer selling these at a cheaper price in Israel, the profit can be increased by marketing them in the animals' country of origin (Portugal in our case) to non-Jewish consumers. Indeed, the findings of this research suggest that it is possible to transport almost 60 times more carcasses, when compared to live animals. Finally, the movement of carcasses rather than live animals presents the opportunity for a more diverse and efficient trade in goods, where shipments comprise of meat and other goods that the destination country requires.

The additional economic and environmental costs of the live trade are driven by a variety of factors including the number of additional steps in the trade, which all require resources and incur costs. For example, for the carcass trade, animals may travel from the farm straight to the slaughterhouse to be slaughtered, before the carcasses are then transported to the port for export to a third country. In contrast, at a minimum, the live trade involves transport from the farm to a quarantine centre, then from that centre to the port for shipping to a third country. In the destination country, the animal will undergo quarantine and fattening to put weight back on (lost due to transit stress) and then increase to the slaughter weight, before being transported to the slaughterhouse for slaughter. Finally, for both the carcass and live trade - the carcass can be transported to where it is required for further processing, packaging, and sale. The additional stages for the live trade require additional inputs, for example, in the form of food, animal husbandry care, veterinary input, water, electricity, fuel for transport vehicles and so on.

These economies of scale demonstrate opportunities for EU businesses and indeed businesses in third countries, to decrease the associated costs economically and environmentally, which in turn can be reflected in profit margins and wider social benefits, including the protection of local farming and meat producing businesses in each country.

A complex trade

The trade is complex with different parties involved in different ways, including a myriad of businesses, organisations, and authorities. This complicated and intricate system of people and organisations operating in different nuanced ways present both challenges and opportunities regarding change. For example, the wider research undertaken and the focus on the case study of the trade in sheep from Portugal to Israel, has indicated that local in-country farmers may be restricted regarding their potential income. Due to the complexity of the trade, number of layers and involvement of large international agri-businesses, farmers are not able to maximise the profit they can generate or influence the trade regarding live compared to a carcass trade, because they are being squeezed by big business who are seeking to increase their profit margins. The growth in large international agri-businesses, has resulted in many steps of the trade being influenced by just a few large companies; with some being involved at every element - from the breeding of livestock to transport, to slaughter, to selling to the consumer through supermarkets (i.e., primary agriculture and secondary industrial, such as processing, packaging, and retail). It is these businesses that are part of the increased layers that are adding cost.

Market growth while reducing negative outcomes

The global population is continuing to grow, and with that the demand for meat is also rising, particularly among emerging markets. As such, indications are that the international market for meat will remain active, with middle income countries leading the way regarding consumption, together with the potential for new markets opening in emerging economies. Although international transport has become easier, it has also been linked to climate change and a negative environmental impact, together with the spread of disease (of both human and other animal species). With this in mind, the movement of carcasses rather than live animals is advantageous – as it can meet the increasing demand from new markets, while lowering the environmental impact compared to the live trade regarding transport and the use of resources (e.g., energy, food stuffs and fodder), together with reducing the risk of spreading disease linked to the movement of live animals.

Despite the high production costs and high output prices of meat, there is still often a mismatch between what countries choose to consume and choose to export, resulting in a situation where a country could be exporting live animals or carcasses, and also importing them. This poses an increased business risk for in-country agriculture and the internal market of that country and has a considerable detrimental impact on the environment and animal welfare through superfluous transport.

Support for change

EU focused research has shown that there is societal support for change from the public, their elected representatives in the European Parliament, and from Member States. However, while the EU is consuming less meat and exports of meat have reduced, live exports of animals from the EU to third countries are on the increase and are four times higher than they were in 2007 – creating a mismatch between public opinion and the realities of the trade. There are also Member States and parts of society that are worried about a change to a carcass-only trade, raising concern as to what this could mean for the agricultural sector and related business. However, the findings of this research suggests that rather than being a threat it could be an opportunity, with benefits for the businesses involved and wider society. One such example of these benefits relates to the Israeli government's existing support regarding lower customs tariffs for carcasses as opposed to live animal import; demonstrating the Israeli authorities support for a carcass trade.

The human factor

Every step of the process from farm to slaughter and beyond, involves people. These people bring different cultural beliefs, traditions, history, and socio-economic backgrounds, whether considering individuals, communities, organisations, or in the wider context countries, people are connected to the trade, from farmer to transporter, to slaughterhouse worker, to consumer, and so on. The culture of the country of origin for an animal, may be very different from that of the destination country, and this needs to be considered regarding how it impacts on all the stakeholders involved – including people and the animals.

Using the case study of Portugal to Israel as an example, with the Jewish religion being the primary faith, the trade is predominantly for a Kosher market. For a carcass trade to operate from Portugal to Israel, Kosher certified slaughter would have to be undertaken in Portugal. At this moment in time, there are not any Kosher certified slaughterhouses in Portugal, so this would need to be addressed for the carcass trade

to be established. While Kosher slaughter respects certain elements of animal welfare, it does not allow pre-stunning before slaughter. This may be the biggest barrier to the carcass trade to Israel, unless it is deemed acceptable within Portugal for Kosher slaughter without stunning on religious grounds. The hindquarters of the animal are not acceptable for consumption, and/or entire carcasses may be rejected at the post-mortem examination in accordance with Jewish beliefs, however, if the animals are slaughtered in Portugal this part of the carcass could be sold to other markets.

It is worth noting that the geography of Israel, and indeed countries in that region where Halal meat would be a requirement, is such that they import large amounts of the meat they consume. The reasons for this are the limited availability of suitable land and water resources, together with the impact of climate. Unlike Kosher slaughter, Halal slaughter does accept certain types of pre-slaughter stunning, so countries with a large Muslim population may be an option for Portugal to export carcasses to, however they still require the certified slaughterhouses for Halal slaughter. In the short-term there are certified Kosher slaughterhouses in Spain (three for cattle and one for sheep), who may be able to take sheep from Portugal to meet any demand (even if this required road transport, it would still reduce the overall journeys animals are currently undertaking). The added benefit of this approach would be the fact that the journeys would take place entirely on the European Union territory, and thus subjected to and controlled by the EU live animal transport regulations to ensure compliance with the best practices in animal welfare (including transport duration, driving speed and quality, animal supervision for welfare conditions such as temperatures, space allowance, loading and unloading procedures, but also animal traceability, biosecurity and so on).

Change and employment

The global livestock and meat sector employs a significant number of people and therefore impacts upon their livelihood. Due to the nature of the trade and the increasing market demand for meat, a move from a live trade to a carcass trade would still require a labour force, however those jobs would need to be redistributed to different parts of the chain. If we consider the chain, the farmer, transportation for short distances, retail outlets (e.g., supermarket) and the consumers, would remain as they are. The case examples explored were based upon the carcass trade, therefore processing and packaging would still require a workforce as it did previously. Change would be most significant in the middle section of the chain, for example this could include agri-businesses who may buy and finish/fatten the animals from the farmer or be involved at other parts of the chain; quarantine centres for live animals; vets involved in animal inspection work; transporters by road and sea and slaughterhouses. Considering the examples given in more detail:

- Agri-businesses – large international agri-businesses who are involved in multiple elements of the chain stand to make cost savings. They would need to redistribute their staffing along the chain, however, which is likely to incur retraining and administrative costs.
- Quarantine centres – while these would no longer be required for quarantine. However, due to sheep farming in Portugal and Israel being largely based around small farms, the need for staff working in collection centres where animals can be collected together pre-slaughter to ensure efficiency on the slaughter line (i.e., operating the slaughter line when they can work to full capacity) may be required. This could be a suitable option for both the source and destination country in relation to the Portugal to Israel case study, but each country's situation would need to be considered taking into account their unique situation.

- Veterinary inspectors – vets will still be required to inspect the animals; however, the nature of the work will change (e.g., no longer required to accompany long-distance maritime journeys). There is also a well-documented shortage of vets globally, therefore redeployment to another role should not be an issue.
- Transporters by road – there will still be a requirement for road transportation, therefore the shift would be from livestock to temperature-controlled trucks.
- Maritime transport – while the employment opportunities for working on live animal transport ships would be removed, these could be replaced with employment opportunities with container ships, which would in many cases be preferential in terms of working conditions.
- Slaughterhouses – for the case example of Portugal to Israel, the internal in-country production in Israel is such, that the slaughterhouses would still be needed. In Portugal increased demand within the slaughterhouses could also create job opportunities. Each country would need to be considered regarding the impact it had on their situation.

Opportunity for improve animal welfare while reducing economic and environmental costs

It is not the focus of this report to explore the impact of the live trade in animals compared to a carcass trade on animal welfare *per se*, as that has been widely reported upon and studied by a variety of stakeholders. However, it is worth drawing attention to the evidence that a carcass trade would enable the chain from farm to slaughter to become shorter, making it possible to reduce the risk of animal welfare being compromised (e.g., morbidity or mortality), due to the stressors experienced by the animals involved in the trade (e.g., being placed in different environments - transport lorries, collection centres, quarantine centres, maritime transport; provided with different food/ fodder, water, and bedding materials; and handled by different people etc.).

By removing the additional steps involved in the live trade and reducing the risk factors impacting on the health and vigour of the animals involved, it would lower the costs associated to maintaining welfare and treating disease and injuries. The animals could be fattened to a body weight at the farm, then transported a short distance to a local abattoir for slaughter, as opposed to being transported, losing condition and body weight, then having to be re-fattened. Together with transport and associated costs, there could be other cost savings on all the inputs that are required in the additional days incurred by the live trade (e.g., in the case study around 12 days). The additional resources currently required, will be having an impact upon the environment (e.g., resource depletion linked to growing fodder, soil degradation, water and land use, methane in the atmosphere etc.), which could be reduced. Finally, regenerative farming practices that promote animal welfare, save money, and renew the environment (e.g., increased biodiversity) could be supported, which would benefit farmers, local communities, wider society, the planet, and the animals involved.

Points of influence

In many cases, the farmer breeding the animals has less influence over the trade than large agri- and meat processing businesses, who may in some cases own and influence every element of the trade from the animals' birth to the product placed on a supermarket shelf for the consumer to buy. These large businesses are well funded and resourced, meaning that they have the capacity to impact on the trade

far and wide, and are ultimately driven by the bottom-line to make a profit for their shareholders or company owners. This can contrast with farmers who for generations have worked with livestock, who are passionate about what they do, and ultimately want to produce livestock that fulfil what the consumer is looking for. In many cases an imbalance has occurred where the farmer is not seeing the profits made through chain and are increasingly disconnected from the consumer. A carcass trade could enable a reconnection between farmers and the consumer, which could have benefits economically, environmentally as well as for society.

A link between the damage being caused by the increasing disconnect between people and the natural world around them, the food they eat and the lifecycles that provide it, is increasingly being shown to have negative impact upon human wellbeing. A shortening of the chain and a carcass only trade could be part of the solution to renewing this connection to the living world, a connection that the human race is dependent upon. This approach does not have to be at the expense of the international agri-businesses, as they are indeed needed, in a world with a growing population, a climate that is changing food production and therefore a need to ensure the world is fed, there is and will be a need to move food around the world, but in an ethical and sustainable way; this report has provided the foundations of demonstrating that this is possible

5.1 Recommendations and next steps

An enormous amount of ground has been covered through this innovative project, reviewing the literature, undertaking research, analysing, and triangulating the data, mapping and modelling it and then preparing this comprehensive report; but as with every piece of research or initiative, it is not the end point but the starting point for future work. As such, we have included recommendations and next steps, which have emerged as result of undertaking this project – reviewing, analysing, and modelling the data sources. It is important to note that these recommendations have been developed as a result of undertaking this project, and further discussion is needed to plan the next stage of activity.

Under each theme listed below, there are several recommendations/potential actions that have been identified by the research team. The themes for the recommendations and next steps include:

1. Current and future case studies
2. Model
3. Engagement, relationship, and network building
4. Stakeholder case studies
5. Applying Human Behaviour Change science in practice
6. Communication, engagement, and dissemination plan
7. Further research, analysis, modelling, and testing
8. Funding, and support for next steps

At this point, these recommendations and next steps do not explore the logistics or limitations as this would be part of any future work.

Case studies recommendations and next steps

1. **Sheep from Portugal to Israel** – continue to collect and test the data taking a longitudinal approach to the data collection, analysis, testing and modelling. This would ensure that the case for change continues to build and becomes more robust and compelling.
2. **Cattle from Spain to Lebanon** - work with organisations to obtain the data that is missing to complete the modelling. Then as for Portugal to Israel take a longitudinal approach to data collection, analysis, testing and modelling.
3. **Cattle from France to Algeria** – for this route, contacts in both France and Algeria need to be established that can support and help with this project (e.g., based locally, NGO, journalist, researcher etc.). If this is possible then the missing data can be collected, and the same approach can be taken as the other case studies.
4. **New routes** - consider future relevant case examples that could be modelled.

Model

5. The model has taken the work of Wageningen University and developed it further for transport from the EU to third countries. The construction principles of the model have enormous potential to be further developed for use by all interested parties. A plan for further research, testing, refinement, and use should therefore be developed.

Engagement, relationship, and network building (see HBC and comms plan)

6. There is a need to develop new relevant contacts in the agricultural sector to facilitate continued data collection that will enable effective development of the business case, and further testing of the findings (e.g., farmers, transport by road and sea, slaughterhouses, quarantine centres, agri-businesses, veterinary inspectorate etc.).
7. Constructive dialogue with the agricultural sector will be essential for demonstrating the benefits of change and working together to achieve this.
8. Workshops could be arranged to demonstrate the potential cost savings and co-create solutions to move towards identified common goals that provide benefit to all (EU and third country stakeholders).
9. Consider whether COP 2023 or 2024 in November to December is an opportunity regarding support for change to reduce the environmental impact of the trade.

Stakeholders case studies

10. An enormous amount of work has been delivered through this project, and there is now the opportunity to further develop case studies for each of the key stakeholder groups, as each have their own unique situations (e.g., farmers may be small, medium, large; mixed or single livestock; involved in one element of the trade or multiple etc.).

11. Through building a picture of the push-pull factors for change for each of the stakeholder groups, and how they would like to engage, it will facilitate the possibility to demonstrate the benefits of change (to them personally, their businesses, their communities, socially, to the wider sector etc.) - so a compelling case for change can be presented.

Applying Human Behaviour Change (HBC) science in practice

12. Even with a compelling case with the benefits presented, people do not always choose to change (e.g., smoking, the continued use of fossil fuels and plastic etc.), therefore research needs to be undertaken drawing upon human behavioural science to understand the factors, barriers, and opportunities to change. As a starting point, the data already collected could be analysed through this lens – HBCL could assist with this.
13. Based upon point 12, further research could be undertaken to build a comprehensive picture of the human factors involved in change and what is needed.
14. The findings of such research would enable informed evidence-based interventions to be designed, developed, and implemented, which could support the delivery of a change to a carcass trade.
15. A Theory of Change could be developed to support a move from a live to a carcass trade. This would include further research, engagement, dissemination, and a pathway to delivering change – identifying what is needed to develop policy recommendations (evidence etc.).

Communications, dissemination, and engagement plan

16. Ideally drawing on HBC research and interventions design, develop and implement a communications plan that can be utilised to communicate the case for change, disseminate the findings of the report and the model, and engage new support and partners.

Further research, analysis, modelling, and testing

17. Economic – a model could be developed to provide insight comparing income generated for a carcass compared to live trade.
18. Examine the costs associated to moving from livestock trucks to temperature-controlled trucks, and from livestock ships to container ships.
19. Examine consumer preferences, attitudes, and beliefs regarding chilled, frozen and fresh meat, together with locally produced versus imported.
20. Environmental – model other emissions and components (e.g., waste, methane reduction by shortening the chain etc.).
21. Evaluate how fewer resource inputs would be required and how this would impact economically, environmentally and at a societal level (e.g., reduced amounts of animal feed required).

22. Research other case examples where change has occurred - a move from a live to a carcass trade is in place (e.g., social impact on employment, the local community, businesses; opportunities and rates of pay, gains and losses; where and how retraining can be used; subsidies, job creation, job migration).
23. Explore what trade deals could be put in place, what tax and customs incentives could create opportunities in this area.
24. Evaluate what policy options could be effective, in supporting and encouraging business to change.
25. Examine the costs associated to the set-up of different slaughterhouse facilities (e.g., mobile slaughterhouses).
26. Examine the use of by-products – fifth quarter.

Funding, and support for next steps

27. The potential of this project to grow, be impactful and truly make a difference is huge but it needs the support, backing, and ultimately the funding to be able to take the next step. Although an enormous amount of ground has been covered the complexity of the trade means that more work is needed, some of which is outlined in the recommendations, but more exists. If significant funding could be secured (e.g., Horizon project funding, grant) a team of experts from relevant fields (including HBCL's team) could be brought together, to undertake a wider study and test possible interventions and policy approaches that could deliver change.

5.2 Limitations

The limitations regarding each method of data collection have been briefly outlined in each relevant section (e.g., regarding the survey, interviews). This section outlines limitations that are relevant across the different sections.

Gaining representation across the sector and geographic case studies

Although many people across several countries have provided input to this work, there were challenges with engaging and gaining access to information and contacts among parts of the sector (e.g., maritime), particular stakeholder groups (e.g., local farming communities) and in certain geographic locations (e.g., Algeria). Some areas of expertise were consulted until saturation was met, and data could be triangulated with other sources, whereas for other information there remains a need to know more and to further verify what was collected. The research team tried to address this issue by actively targeting contacts in our network where sources of data and contacts were weak.

Interpreting the data (and report)

We all have the tendency to take in new information that 'fits with' (confirms or supports) our current knowledge, beliefs, and values. This is called confirmation bias (Nickerson 1998) and examples can negatively impact our understanding of a situation. The issue is recognised in the justice system, for example the tendency for police to respond to confirming rather than disconfirming information about a

suspect. It is important that we try to look at an issue through many lenses to try to avoid our own confirmation bias.

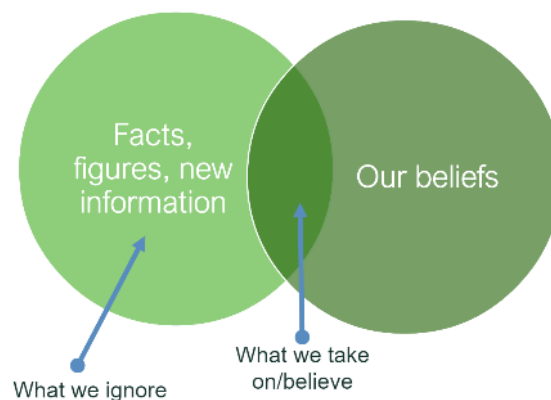


Figure 22: Illustration of 'confirmation bias'

Another factor that presents a barrier to both gaining an objective insight into the situation and to reading this report in an unbiased way, is that of cognitive dissonance. Humans seek consistency between their values and behaviours (Festinger 1957) and sometimes when presented with information that goes against their current beliefs and knowledge, they experience cognitive dissonance and struggle to fully take on the new information. There are well-documented ways to resolve cognitive dissonance including changing one of the concurrently held beliefs, gaining more knowledge to outweigh the dissonant belief, and reducing the importance of the dissonant belief (summarised by McLeod 2018).

This project has brought together unprecedented diversity and volumes of data, to consider the carcass compared with live trade in animals for slaughter from different angles. Doing so has provided novel, robust, and multi-faceted insight into the issues facing the agricultural sector more widely and at more localised case study level between one EU country and a third country. However, the project was limited by the lack of data available examining this area; greater clarity on the overall trade, the economics and who is involved at what level would yield further conclusions about the trade.

In addition, numerous complex and interlinking issues have occurred in the five years prior to this project, including the COVID-19 pandemic, the cost-of-living crisis, and additional attention to the impacts of climate change; cumulatively, these events have far-reaching effects that interact with one another and make it challenging to identify specific drivers of the factors impacting on the trade.

Finally, although great effort was made to include a broad range of data, there still exist gaps in our findings, which we have outlined in the recommendations for next steps.

5.3 Considerations, opportunities, and conclusions

It is important to note that this groundbreaking project has covered new ground but there is still more work to do. As outlined, the sector and the trade it engages in, is comprised of many stakeholders operating in a complex system made up of many parts that are diverse and nuanced. This system covers different structures, cultures, approaches, and locations, and as such, the findings of this research need

to be considered with this in mind. The research, analysis and modelling undertaken, lays the foundations for further work that could ensure that the benefits identified are utilised to help the sector, the environment, society, and the animals involved.

Final comment

The trade in animals for slaughter is part of a complex, interconnected system. The research team has worked to guide the reader of this report on a journey exploring the benefits and challenges of carcass over a live trade in animals for slaughter from the EU to third countries. The report makes a business case that supports the benefits of moving to a carcass trade, through economic and environmental cost savings, and explores the social impact of such a change.

The research team are aware that the timing of this report is important with the European Commission currently examining changes to animal welfare legislation, which includes transportation and slaughter. Therefore, it is hoped that this report can be shared and utilised by those working to improve the lives of animals, people and the planet, to ultimately drive and support change through demonstrating the benefits to the sector. We hope that this report can be a catalyst for change in relation to this work with Eurogroup for Animals, its members, and beyond.

We would like to take this opportunity to thank all of those who contributed to this report, and to thank the Eurogroup for Animals for funding this innovative and much needed area of research.

Thank you for your time in reading this report, should you have any questions or would like to explore the opportunities to utilise the findings of this project further, please contact Jo White, Human Behaviour Change for Life Co-Director at jo@hbcforlife.com

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