

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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**Faculty of Tropical
AgriSciences**

Meat production and consumption: Case study of Argentina

Diploma thesis

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Declaration

I hereby declare that this thesis entitled „Meat production and consumption: Case study of Argentina“ is my own work and all sources have been quoted and acknowledged by means of complete references.

In Prague 24th April 2015

.....

Kristýna Mudrová

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Abstrakt

Hlavními cíly diplomové práce bylo posoudit účinky rostoucí spotřeby masa na globální udržitelnost, analyzovat dopad dvou scénářů zaměřujících se na produkci masa a s tím spojené externality v Argentině a diskutovat kompromisy o zlepšení globální udržitelnosti a dopadů na Argentinskou ekonomiku.

Přehled literatury se zaměřoval především na dopady produkce masa na životní prostředí a udržitelnou spotřebu masa. Výzkum zahrnoval tři hlavní části. První část obsahovala výzkum sestavený z informací o celosvětové a Argentinské spotřebě masa, výrobě a exportu, dále environmentálních a ekonomických dopadech produkce masa a s tím spojené využití půdy a vody v Argentině. Ve druhé části výzkumu byla zkoumána Argentinská politika produkce masa a její dopady. Ve třetí části byly vytvořeny jednoduché modely vykreslující účinky vývoje spotřeby masa.

Argentina je jedním z největších konzumentů masa, především hovězího, a je prognózován nárůst produkce, spotřeby a vývozu. Masový průmysl patří mezi nejvýznamnější odvětví v Argentině právě díky výrazným přínosům v ekonomice. Obzvláště exporty hovězího masa představují významnou komparativní výhodu. V zájmu vlády je zvyšování produkce masa a vývozu, což je představuje ziskovost. Tento nárůst je ovšem v rozporu s obrovskými dopady na životní prostředí v podobě produkce emisí CO₂, ztráty biologické rozmanitosti a smršťování přírodních zdrojů.

Práce přispěla k otázkám ochrany životního prostředí vyplývajících z výroby masa a zdůraznila nutnost koncentrace na udržitelnou spotřebu masa. Argentina figurovala jako příklad dopadů masného průmyslu na životní prostředí a tento příklad by mohl být aplikován celosvětově. Tato diplomová práce by mohla být použita jako počáteční vodítko pro další výzkum soustředující se například na informovanost spotřebitelů o vlivu produkce masa na životní prostředí a jejich přístupu k udržitelné spotřebě masa.

Klíčová slova: Životní prostředí, přírodní zdroje, udržitelnost, masový průmysl, obchod s masem.

Abstract

Main aims of the diploma thesis was to assess the effects of growing meat consumption on the global sustainability, to analyse the impact of two scenarios addressing meat production externalities on Argentina and to discuss trade-offs of the need for improving global sustainability and the impacts on Argentina economy.

Literature review focused mainly on environmental impacts of meat production and sustainable meat consumption. Research included three main parts. The first part involved desk research compiled of information on meat consumption, production and exports in Argentina and worldwide, environmental and economical impacts of meat production and land and water use associated with meat production in Argentina. In the second part of the research was analysed Argentinian policy of meat production and its impacts. In the third part, simple models predicting effects of meat consumption development were created.

Argentina represents one of the largest meat, and particularly beef, consumers and the meat production, consumption and exports are expected to increase. Meat industry belongs to the most important sectors in Argentina due to its significant contribution to economy. Particularly beef meat exports represent significant comparative advantage. The interest of the government is to keep increasing meat production and exports, which would be profitable, is contradictory with huge impacts on environment in form of CO₂ emissions production, biodiversity loss and shrinking natural resources.

The thesis contributed to environmental issues arising from meat production and highlighted the need of switching to sustainable meat consumption. Argentina figured as example of impacts of meat industry and this example could be applicated to the whole world. This diploma thesis could be used as an initial clue for another research concentrating for example on awareness of consumers about environmental impacts of meat production and their attitude to sustainable meat consumption.

Key words: Environment, natural resources, sustainability, meat industry, meat trade.

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GDP	Gross Domestic product
FAO	Food and Agriculture Organization
OECD	Organisation for Economic Co-operation and Development
UN	United Nations
IISD	International Institute for Sustainable Development
SPSS	Sustainable product – service system
GHG	Greenhouse gas
SOL-M	Sustainability and organic livestock model
UNCTAD	United Nations Conference on Trade and Development
CO ₂	Carbon dioxide
APEC	Asia-Pacific Economic Cooperation
USDA	United States Department of Agriculture
EPA	United States Environmental Protection Agency
SCAR	Standing committee on Agricultural Research

1 Introduction

The diploma thesis is aiming increasing global meat production and consumption and its adverse impact on global sustainability. Due to the wideness of the topic, Argentina and its policies figures in this thesis as an example, how livestock industry influences economy and environment.

Argentina is a country with rich natural resources and climatic conditions suitable for agriculture. The country is sparsely populated and the huge areas of land can be used as pastures or arable land. Thanks to that, the country is one of the world's principal food producer and exporter, especially in case of beef meat. The beef meat production, consumption and export have always been one of the main domains of Argentina, which has always had a strong position in economy. Thanks to this intensive activity became Argentina one of the greatest beef exporters. Between year 2001 and 2010 was in the country consumed on an average 84% of the total production, whereas in other South American countries is the beef usually more devoted to global markets (Guevara, Gruenwaldt, 2012). But since 2002 has been detected increasing production of poultry meat and its export has surpassed beef exports in 2011 (OECD, 2014). The reason for increasing focus on poultry meat are higher beef prices, land moving from pastures to crops as a result of government's restrictions on beef exports, and growing vegetarian market in the country, which has impact on decreasing beef consumption (Wessler B, 2013). Anyway, beef and poultry belong to the most consumed meats in the country. Argentina belongs to the largest producers and consumers of the meat and the meat consumption is expected to growth (UN 2012, OECD 2014). The meat production goes through succes, but on the other hand contributes to environmental problems such as air and water pollution, biodiversity loss, land degradation, soil fertility, climate change or carbon emissions (Steinfeld et al, 2006). With increasing livestock production also increases demand for cattle feed, which is land-demanding for cultivation. Argentina is nowadays facing the question, if the present patterns of huge meat production and consumption lead to sustainability and food security of the future generations. The main principle of sustainability is to "create and maintain the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations." (EPA, 2014).

2 Aims of the Thesis

The diploma thesis had several objectives leading to deep analysis of meat production, consumption and export, meat consumption, meat production and environmental impacts and sustainability. Possible interactions between those main areas were examined and due to that were set up following objectives:

1. To assess the effects of growing meat consumption on the global sustainability.
2. To assess the effects on Argentina´s economy and environment
3. To assess the impact of two scenarios addressing meat production externalities on Argentina
 - a. Scenario 1: Argentina measures to limit negative environmental impacts of meat production
 - b. Scenario 2: reducing meat consumption in developed world
4. To discuss trade-offs of the need for improving global sustainability and the impacts on Argentina economy and society

3 Literature Review

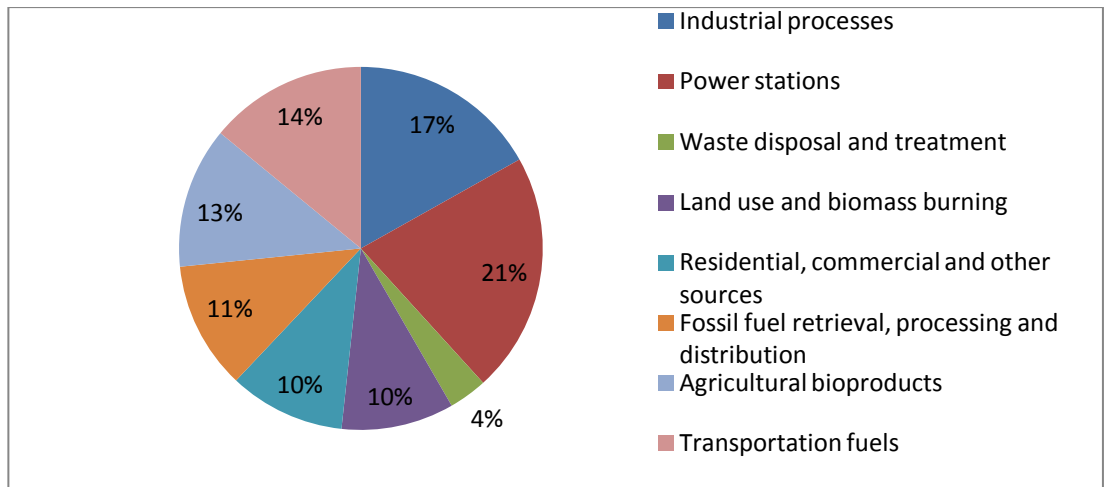
Literature review is concentrating on agricultural transition from small scale farming to large scale farming and its environmental impacts and economic benefits on the other side. The chapter 3.1. is focusing on impacts of livestock industry on environment, namely on requirements on land use and water use, atmosphere and climate. Chapter 3.2. analysis sustainable meat production and consumption and its impacts on natural resources and environment.

3.1 Meat production and impacts on environment

The demand for meat products is supposed to double by 2050 and already nowadays, the livestock industry is one the most critical contributor to the most immediate environmental issues. According to FAO (2012), the livestock sector is the fastest growing sector compared to other agricultural sub-sectors. Cederberg (2014) thinks that animal and crop production and the manure management need to be improved and the animal products' consumption and production also should be discussed. 30 % of the entire land surface is used as pastures for livestock and other 33 % of land is used as arable land for cattle's fodder production. Especially Latin America is facing deforestation in order to create new pastures. For example approximately 70 % of the former Amazon forests have been transformed into pastures (FAO, 2006).

The livestock production in Argentina is supposed to growth by 17 % in 2020 and by 26.3 % in 2023 compared to values from 2013. As the meat production, also meat consumption is predicted to growth by 6.7 % in 2020 and 12.4 % in 2023 (OECD, 2014). According to Steinfeld et al (2006), the meat production has impact on environment, it influences air and water pollution, soil fertility and land degradation, climate change, carbon emissions, biodiversity loss, etc. In the research was assessed that livestock industry contributes to land and water degradation and covers 18 % of all greenhouse gas emissions, which is more than transport (FAO, 2006). Livestock sector also contributes with 37 % to total human methane production and with 64 % to ammonia production, which significantly influences acid rain (FAO, 2006).

Figure 1: Annual greenhouse gas emissions by sector in 2011

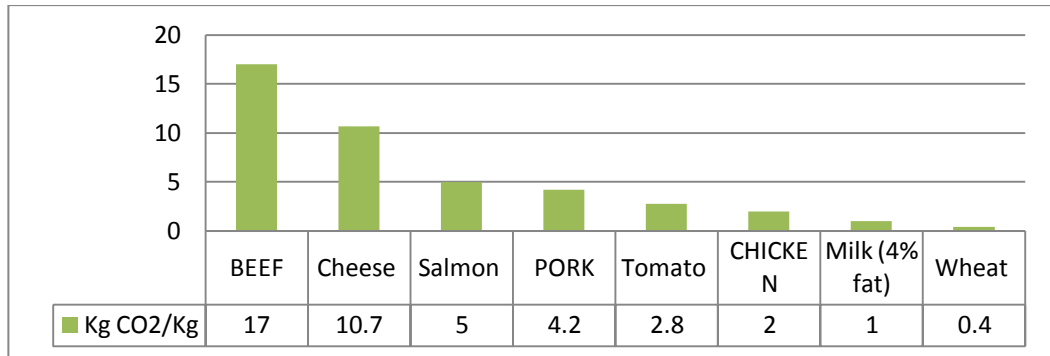


Source: Goffman E. 2012.

Research compiled by the Environmental Working Group (Hamerschlag K, Venkat K. 2011) was aimed at full cycle analysis of all meat types. Lamb was marked as meat with the highest production of greenhouse gas emissions. Second worst results were shown in case of beef meat, followed by salmon and pork meat. Breeding of lamb, beef and pig is the most resources demanding and due to that fact have those red meats the worst overall environmental impact (Hamerschlag K, 2011). On the contrary, results showed that chicken breeding has the lowest impact on climate change.

Similar research was conducted by Lantmannen Foods (City University of Hong Kong, 2013) and it was calculated, that 17 kilos of carbon dioxide is produced per 1 kilo of beef, 4.2 kilos of carbon dioxide is produced per 1 kilo of pork and 2 kilos of carbon dioxide is produced per 1 kilo of poultry. Out of all meats, chicken breeding burdens the least the environment.

Figure 2: The comparison of food's carbon footprint (Kg CO2/Kg)



Source: City University of Hong Kong, 2013.

Goffman (2012) explains that meat production in factory farming has huge impact on environment because livestock is in stables with no contact to vegetation and it is feeded with fodder containing hormones and antibiotics in order to maximize the growth. Excrements of those animals are concentrating in one place, which can cause health risks. Advantage of Argentina is a huge area, which is used for grazing. Grass-fed and organic beef breeding is recommended by many experts, because of savings in energy, reduction of pesticides and chemical fertilizers and primarily decrease of carbon footprint and risk of diseases. On the other hand, high-yield farming system is not so land demanding, which has protective impact against soil carbon, which would be gassed off during using the land. Disadvantage of beef production is that cows produce methane and a “single cow can produce as much as 500 liters of methane per day.” (Goffman, 2012). In comparison with cows, pigs don't produce methane and pork production releases less than 1/3 of beef's emissions (Hamerschlag K, Venkat K, 2011). Pork produces significantly less emissions than beef.

Poultry production has the smallest environmental impact, because the poultry produces less than one half carbon than pork and less than one quarter than beef. Adler (2008) says that limitation of meat consumption only to chicken, would have not only health and financial benefits, but primarily environmental benefits. But few harmful effects are connected with chicken breeding. First of all, there is a risk of seeping manure into the land, which would cause bacteria spreading, or washing into water sources as rivers or streams, which would deteriorate water quality and risk of creating “dead zone“ would increase. Other negative environmental effects are antibiotics and hormones included into chickens' fodder (Hamerschlag K, 2011). In study of Allison (2007) was revealed that

organic and free-range chicken production might have worse environmental impacts, because the energy for the organic production is by 33 % greater than for the factory-farm production and in case of free-range production is used by 25 % more energy. Regarding the global warming, the organic production represent 46 % higher potential and free-range production 20 % higher potential, which is due to longer time that chickens need to grow. Huge strenght of organic and free-range productions is for example reduction of pesticides.

Table 1: To produce 1 kilogram of meat it takes....

	Beef	Pork	Chicken
Litres of Water	15 500 l	4 800 l	3 900 l
Kilos of Grain (corn)	11 kg	7 kg	4 kg

Sources: Apec. 2012. Water footprint organization. 2013.

Water is a key determinant of productivity and livestock industry is considerably dependent on water resources. According to Steinfeld et al. (2006), over 8 % of global human water use is exhausted on livestock production. According to FAO (2006), the livestock business is the most water resources damaging sector increasing the water pollution, eutrophication¹ and the degeneration of coral reefs. The principal causes of water pollution are animal wastes, antibiotics, hormones, chemicals, fertilizers and pesticides, which are used for feed crops spraying. Grazing contributes to water cycles disturbance and reduces above and ground water resources' replenishment. It must be also taken into account that huge amount of water must be used for forage production (FAO, 2006).

High-yield farming gave everyone opportunity to eat, but huge environmental impacts are not usually considered. The Environmental Working Group (Hamerschlag K, Venkat K. 2011) gives example on United States: "If everyone in the U.S. ate no meat or cheese just one day a week, it would be like not driving 91 billion miles – or taking 7.6 million cars off the road." Solution to environment load is reduction of meat consumption or switching to lower impact animals, such as chicken or fish (Goffman E, 2012). The FAO's (2006) inter-institutional consortium LEAD (Livestock, Environment and Development) suggest remedying steps regarding:

¹ "Eutrophication is characterized by excessive plant and algal growth due to the increase availability of one or more limiting growth factors needed for photosynthesis, such as sun light, carbon dioxide and nutrient fertilizers." (Chislock M,et al, 2013).

- **Land degradation**
 - Control of accessibility, removing barriers to mobility on communal grazing land, application of soil conservation practices and silvopastoralism, removal of livestock from sensitive areas, fee-compulsory system for environmental services livestock-based land to increase land degradation.
- **Atmosphere and climate**
 - Modification of livestock's fodder reducing fermentation and methane emissions, establishing of biogas plant for manure recycling.
- **Water**
 - Increasing the capability of irrigation systems, implementation of full-cost water pricing together with taxes with aim to prevent large-scale livestock concentration near to cities.

3.2 Sustainable meat production and consumption

There live 41 900 thousands people in Argentina and this number is expected to growth to 46 800 thousands (World Population Statistics, 2014). With this number will grow food production, including meat as well. Nowadays, the increasing livestock production and the demand for meat, and also for eggs, milk and dairy products, have became a threat for food security in form of environmental problems as land degradation, water and air pollution, deforestation, biodiversity loss and huge water usage (Steinfeld, 2006) and those problems will be increasing with increasing population. Sustainable consumption and production is the only way, how to decrease the risks and impacts on environment.

During the Oslo Symposium in 1994 was the sustainable consumption and production defined as “the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations.” (IISD, 1994). The concept aims three areas of changes: consumption reducement, shifting consumption patterns to a more suitable pattern and reducement of waste, recycling.

The problem with achieving those changes and sustainable consumption patterns is, that many of them cannot be realized without changes in production, infrastructure and

social context. (Ratnger T, 2014). Sustainable product-service system (SPSS) is proposed by some authors. The main idea of SPSS is that consumers purchase utilisation of products in form of mobility instead of products as cars. The strength of SPSS is in combining environmental protection and non-reduced welfare (Mont, 2002). According to Mylan (2014), the advantage of SPSS is linking consumption and production together, but on the other hand she thinks that social practices approach from the sociology consumption should be adopted. Mylan (2014) and Warde (2005) claim that it is not sufficient to educate or persuade individuals to change the consumption patterns, because it would not lead to their change. According to those two authors, the consumption practices must be changed.

Ratnger et al. (2014) claims that it is necessary to change the food consumption patterns, especially in the most developed countries of the world. Right now, the attention of the most policies and researches is paid for shifting toward sustainable food product and food losses, which represent about 1.3 billion tonnes per year, one-third of the produced food.(Gustavsson et al., 2011). Parfitt et al. (2010) explains difference between **food losses** and **food wastes**. Food loss is associated with the early stage of the food supply chain distinguished by a system with low investment into technologies and processing. Food wasting is typical for the last stage of the supply chain and refers to behaviour of consumers and suppliers. In both stages, the losses are consequence of product's tendency to perish. There are three reasons causing the food losses: proper facilities' and equipment's deficiency, knowledge deficiency and poor discipline. These reasons are results of poverty, lacking or low level of education and insufficient institutional framework (Meyer et al., 2013). By contrast, food wasting is a case of the developed part of the world and it indicates to lack of knowledge, how to store the food or no interest in managing the food in a proper way.

Achieving the sustainable food consumption patterns might not be easy because of its need to create new interactions between producers, retailers and consumers. One of possibilities, how to achieve sustainable consumption patterns is the reduction of food consumption, which is as a principle difficult, especially for people, who need to increase their intake of nutrients. (Mont, 2002). The shift toward sustainable food consumption concentrates mostly on reduced consumption of meat or increased consumption of organic products and locally produced food. Especially eating locally represents energy savings, reduction of greenhouse gas (GHG) emissions and limitation of resources import. Organic

products are distinguished by low dependence on fossil fuel-based inputs and more integrated production. Organic meat production uses ecological resources as natural pastures and fodder, which does not contain fertilisers and pesticides. (Kumm, 2000). Kumm claims in his research that in case of beef and lamb, organic production can be more sustainable than conventional one, but this statement can not be applied in case of pork meat. But at the same time, the costs and production of nitrogen and greenhouse gases are larger than in case of conventional pork breeding, bigger areas are needed for grazing.

FAO has created scenarios, which reflect potential shocks for food systems and this project evaluates the possible impact on food availability and land use after switching from conventional to organic livestock production. According to FAO's concept note of Sustainability and Organic Livestock Model (SOL-M), organic and grassland-based livestock production have a potential to contribute to globally sustainable production because of:

- Multiple beneficial environmental impacts and capability of protecting natural resources (Stolze, 2000. Mäder, 2002).
- "Potential for improving productivity and profitability of farming activities in developing countries as compared to traditional systems" (Badgley, 2007. Bolwing und Gibbon, 2009, UNCTAD, 2009).
- Capability of contributing to sustainable rural livelihoods (Krystallis, Chrysohoidis, 2005. Nemes, 2009).

Table 2: SOL-M impacts of scenarios on food availability and the environment

	Base year 2005-2009 Current situation	Scenario 1 2050: Baseline according to official FAO forecast	Scenario 2 2050: 50% reduction of concentrate use	Scenario 3 2050: 100% reduction of concentrate use	Scenario 4 2050: full conversion of livestock to organic management	Scenario 5 2050: combination of scenarios 3 and 4
Agricultural land						
Human population						
Available food energy for human consumption						
Available food protein for human consumption						
Share of livestock products						
Share of plant products						
Nitrogen surplus						
Phosphorus surplus						
Energy use						
Global warming potential						
Land degradation potential						
Deforestation pressure						
Toxicity potential						
Grassland overexploitation						
Biodiversity						

Source: FAO. Sustainability Pathways. 2012

Explanatory notes:

The direction of the arrows show increasing or decreasing tendencies in the scenario

show constant trends or minor changes (less than 5 %)

shows a development that is considered as beneficial from societal perspective

shows a development which is considered harmful from a societal perspective

The scientists Stehfest, Bouwman, van Vuuren, Elzen Eickhout and Kabat created four scenarios of diet change, which would lead to sustainability. The first scenario is based on substitution of ruminant meat, as beef, sheep or goat, by plant proteins. The second scenario suggests complete reduction of meat consumption and the third scenario assumes complete reduction of all animal-based products' consumption. The fourth, and the most realistic, scenario deals with so-called "healthy diet", which is characterized by decreased consumption of meat. In case of the first three scenarios, significantly lower land requirements, mainly to grassland, would be expected in 2050. However, even the realistic scenario of "healthy diet" would evince decreased grassland and cropland requirements. The greenhouse gas emissions would be also expected to drop significantly. The biggest gas emissions' decrease would be again more significant in case of the first three scenarios.

4 Materials and Methods

Methodology is divided into three main subchapters: study area description, data collection and data analysis. The subchapter study area description briefly describes Argentina in terms of agriculture, subchapter data collection informs, which data and for which parts were used and the subchapter data analysis describes, how the data was processed.

4.1 Study area description

Figure 3: Map of Argentina²

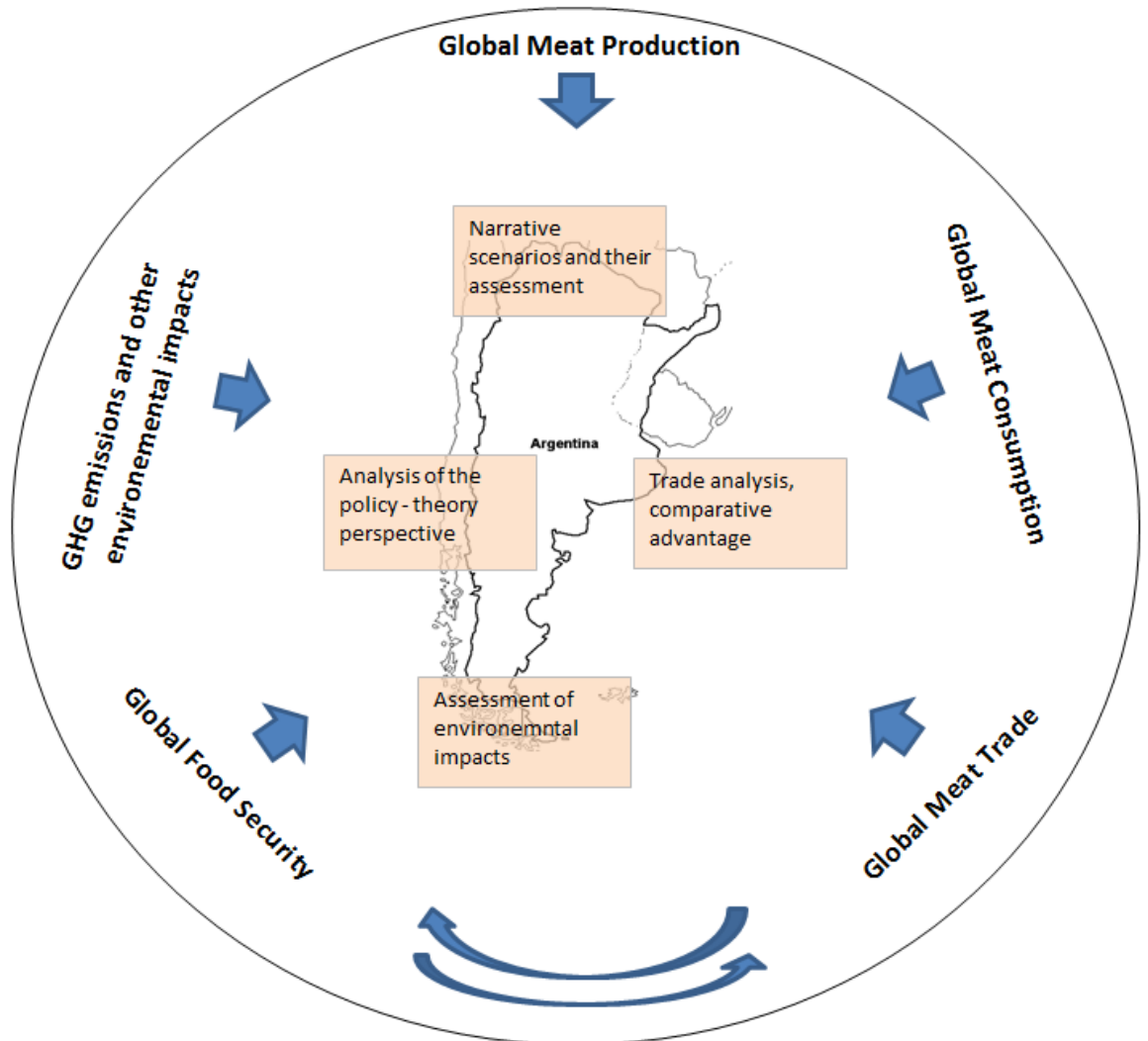


Argentina is a country with strong concentration on livestock industry, especially cattle breeding in extensive pasture-based systems. The Argentinian's area is equal to 3 761 274 km² and the total number of inhabitants was 41 660 417 in 2013 (Ministry of Foreign Affairs of the Czech Republic, 2014). Huge parameters of the country with relatively low number of inhabitants and primarily with favourable climate, a subtropical and temperate zone of the southern hemisphere are more than convenient for using the land for grazing. The livestock production is concentrated in two sectors. The first one is the commercial farming system, which is capital-intensive and export-oriented, and the communal and subsistence sector characterized by pastoralism and agro-pastoralism. The most intensive region are the Pampas (green area in the picture), where 61 % of beef is produced and 65 % of local farms concentrate on livestock production. 35 % of those farms run the complete production cycle (Rótolo et. al, 2007). Main problems and limitations of livestock production are usually connected with low national economic stability and increased aversion to risk, exportation problems, problems to obtain credit for investment into production and environmental degradation as soil erosion or soil fertility (Garbulsky M, Deregibus V. 2006).

² Source: CDC. 2014

4.2 Overall approach

Figure 4: Conceptual framework



The overall approach is summarised in Figure 4. We consider two levels of analysis of the sustainability of meat production and consumption: i) the analysis of global trends and issues linked to future global food security and climate change, and ii) the case study of Argentina meat production and consumption. Actually the level i) is a review of the most recent literature and global statistics on the issue, providing the context for the case study (ii).

The case study has four main components:

- The assessment of Argentina comparative advantage using Balassa index and the review of recent production and consumption trends.
- The assessment of environmental impacts as GHG emissions

- The analysis of the recent beef meat sector policy in Argentina, particularly the imposition of an export tax on beef meat
- And the development and the assessment of two scenarios of the development and policies for enhancing sustainability of meat production in Argentina in the narrative way.

4.3 Data collection

The diploma thesis largely rests in desk research of global meat production and consumption secondary data.

- Studies and scientific publications about meat consumption and its sustainability, impacts of meat production on environment and about agricultural systems and livestock industry in Argentina were used. Based on those data and information, values referring to contribution of meat production to carbon footprint CO₂ and land and water use demand in livestock production was calculated and environmental impacts were discussed.
- Secondary data as Agricultural Outlook of OECD and FAO were used to determine meat production, consumption and exports in Argentina and worldwide. The same source was used also for comparing the share of Argentina on the world's meat production, consumption and export. For meat production and impacts on Argentinian environment and economy. The data about meat production and consumption were also completed and compared with secondary data mostly from UN Food and Agriculture Organisation, United States Department of Agriculture, World Bank, Globe International, Ministerio de Agricultural, Ganadería y Pesca or United States Environmental Protection Agency.
- Source of data and parameters for Balassa index calculation was used from UN comtrade.

4.4 Data processing

Due to the comprehensiveness of the topic, Argentina was chosen as an example of impacts of meat production and its policy, which could be applicated globally. The reason for choosing Argentina as a model country is that Argentina is characterized by one of the world's biggest per capita meat consumption. The other reason is that the meat production

and consumption in Argentina experienced some turbulences linked to price soaring and policies addressing it.

This diploma thesis focused mostly on beef and veal meat, pigmeat and poultry meat, because according to FAO (2014): „The most common sources of meat are domesticated animal species such as cattle, pigs and poultry and to a lesser extent buffaloes, sheeps and goats.” This argument is supported by WorldWatch Institute (2015), which claim that mainly beef, poultry and pork are the most produced types of meat. Values regarding beef and veal, pork and poultry meat are more accessible, compared to other types of meats.

The values were analysed in the time period from 1995 to 2013, because the data for the world´s meat production and consumption were accessible from 1995. To be able to compare those world´s values with Argentina, time period from 1995 to 2013 was decided to be uniformly stated and analysed. Further more, the time period of 18 years is long enough to show development and changes in trends.

The whole research was conducted by using MS Office Excel and divided into following structure:

1. Desk research
 - a. Data on meat consumption and production worldwide and in Argentina
 - b. Environmental and economical impacts of meat production in Argentina
 - c. Land and water use associated with meat production in Argentina
2. Argentinian meat policy analysis
3. Narrative models for analysing policy options enhancing sustainability of meat production
 - a. Scenario 1: Argentina measures to limit negative impacts of meat production
 - b. Scenario 2: Reducing meat consumption in the most developed world

The particular parts of the research have consequent connections between each other. Desk research summarized the values of meat production, consumption and exports worldwide and in Argentina, which enabled to compare the Argentinian values with the world values. Subsequently were the data referring to meat production in Argentina used for calculation and evaluation of economical and environmental impacts. After that, Argentinian meat policies and their impacts were analysed as an example, what would be

global impact of particular policies. In the following step were set up scenarios and each scenario showed changes in meat production. Depending on the different values, changes and differences of environmental impacts were analysed.

- **Desk research**

- Data on meat consumption and production worldwide and in Argentina**

The data on world were summarized in three figures showing the worldwide trends of meat production Figure 6, worldwide trends of meat consumption Figure 8 and worldwide trends of meat exports Figure 9. The global intensity of meat production according to regions was shown in Figure 5 and intensity of meat consumption according to regions was shown in Figure 7. The data on Argentina were summarized in figures: meat production in Argentina Figure 10, meat consumption in Argentina Figure 11 and meat exports in Argentina Figure 12. Those data were used as initial information, which was base for further calculations, and also as illustration of meat's production, consumption and exports development. The Figures were used as a graphical instrument, which enabled easier understanding.

Subsequently, the data referring to the whole world and Argentina were summarized into 3 tables attached as Annexes 2, 3 and 4. Each table included values from particular category: meat production, meat consumption and meat exports. And each table involved values for all types of researched meat. In every category was for each year and each type of meat calculated the percentage share. The goal was to evaluate the percentage share of Argentina on the world's meat production, consumption and exports

- Economic importance and environmental impacts of meat production in Argentina**

- Economic importance of meat production**

Connections of meat production and Argentinian economy is showed in Table 4, which expresses agricultural value added in percentage of GDP. The main aim was to compare the values with particular years and discuss changes in meat production and their reflection to the GDP.

The calculation of Argentina's comparative advantage was conducted based on Balassa index of revealed comparative advantage of Argentina. This index reveals

significance of analysed item. If the index for a given product is more than 1, the product represents a significant item. If the index is less than 1, the product involves no specialisation (CBS, 2012). The Balassa index is calculated according to formula:

$$RCA_{ij} = \frac{\frac{x_{ij}}{X_i}}{\frac{x_{aj}}{X_a}}$$

Where:

- **X_{ij}** represents exports of product j from country i
- **X_i** represents total exports from country i
- **X_{aj}** represent total exports of product j from the reference area (excluding total exports of product j from country i)
- **X_a** represents total exports from reference area (excluding total exports from country j)

Only values in million US Dollars for total meat export were accessible. Export values in US Dollars for particular types of meat were not available. According the UN comtrade (2014), the values, which were shown in Table 8, are as following:

- **X_{ij}** = \$ 1 890 798 836 (Export of meat and edible meat offal by Argentina)
- **X_i** = \$ 76 633 913 944 (Total exports of Argentina)
- **X_{aj}** = \$ 121 416 744 190 (Export of meat and edible meat offal excluding Argentina)
- **X_a** = \$ 17 862 681 518 417 (Total exports excluding Argentina)

As a reference area was chosen the whole world in order to determine the comparative advantage not only in particular area, but worldwide. The Balassa index was calculated as following:

$$\frac{(1\ 890\ 798\ 836 / 76\ 633\ 913\ 944)}{(121\ 416\ 744\ 190 / 17\ 862\ 681\ 518\ 417)} = 3.6$$

Balassa index was also calculated for countries Brazil, USA, Germany, Australia and Netherlands, which are considered to be the largest exporters in the selection of meat and edible meat offal (UN comtrade 2014) and the results were shown in Table 9 to be compared with Argentina. Table 9 was created based on the model of RCA table compiled

by European Centre for Advanced Research in Economics and Statistics (ECARES) in 2005.

Environmental impacts of meat production

Changes of agricultural emissions produced in Argentina were expressed in Table 7. Only years 2000, 2005, 2008 and 2010 were accessible. Values of agricultural emissions referring only to the meat production were not available. In both cases were used just secondary data.

Contribution of meat production to carbon footprint CO₂ carbon dioxide was calculated based on the data of meat production in Argentina and on the assumption, that 17 kilos of carbon dioxide is produced per 1 kilo of beef, 4.2 kilos of carbon dioxide is produced per 1 kilo of pork and 2 kilos of carbon dioxide is produced per 1 kilo of poultry. The results were re-calculated to metric tonnes and showed in Figure 13, which visually expressed the differences of CO₂ production between different types of meat. Results of CO₂ emission for all types of meat were summarized into one table together with number of inhabitants for each year. From those two types of values was calculated amount of CO₂ emissions produced by meat industry per capita and afterwards compared with total CO₂ emissions per capita. Only years 1995 – 2010 were evaluated. Data from 2011 were not available.

After that, the average values from both results of CO₂ emissions per capita were calculated as total CO₂ emissions produced by meat industry divided by population. Table with calculations was attached as Annex 5. Average contribution of CO₂ emissions per capita produced by meat industry was compared with total CO₂ emissions per capita and discussed.

Land and water use associated with meat production in Argentina

Due to inaccessibility of information about land, water and grain use, the data were calculated and displayed in Table 8. In case of water and grain demand, the meat production in thousand tonnes per year (OECD, 2014) was used as the principal information. The value had to be recalculated in kilos to be able to reach the values about water in grain demand. The water demand was calculated on the presumption that 15 500 litres of water is needed to produce 1 kilo of beef meat, 4 800 litres of water is needed to produce 1 kilo of pork meat and 3 900 litres of water is needed to produce 1 kilo of poultry

meat (Water Footprint organization, 2013). The demand of grain, which is used as forage in feedlots, was calculated on the presumption, that 11 kilos of grain is needed to produce 1 kilo of beef meat, 7 kilos of grain is needed to produce 1 kilo of pork meat and 4 kilos of grain is needed to produce 1 kilo of poultry meat (Apec, 2012). It must be highlighted that the animal fodder is usually a mixture of different types of grains, but usually the corn creates majority of the forage. Based on that, the calculation was aiming only corn. Due to taking into account one type of forage grain only, the values are just approximate, because it would not be possible to find out the exact composition and its percentage share in the mixture. The land demand for grain production was calculated on the assumption that the Argentinian average yield of corn between 2006 and 2011 was 6.6 tonnes per hectare (Global Yield Cap Atlas, 2012). The information about pastures area was not available, so the land demand was calculated only for forage production.

As shown in Annex 6, the grain production area demanded for beef, pork and poultry industry was summarized and re-calculated from hectares into kilometers squared to assess the percentage share of grain production area on the total agricultural land. The comparison was related to the time period from 1995 to 2012 only, because the data for 2013 were not available. For each year was calculated the percentage share of grain production area on the total agricultural land. From the percentage values was calculated the average value.

- **Argentinian meat policy analysis**

In the course of the research was realised that the substantial changes in Argentinian meat production are closely connected with the policy which aimed at protecting domestic high consumption of beef meat. Having limited access to data was decided to use theory in order to analyse effects and to compare findings with actual production, consumption and trade figures. The theoretical considerations are presented in standard supply and demand charts as Figure 14: Introduction of export tax between 2006 to 2008, Figure 15: Conversion of pastures into arable land and Figure 16: Beef moving in feedlots, improvement of technologies.

- **Narrative models for analysing policy options enhancing sustainability of meat production**

A common technique was used in foresight to emphasize the urgency of an action and to assess its possible options. The core of this technique was to select limited number

of distinctive scenarios (in case of this diploma thesis 2) contrasting the possible developments or actions to avert or support some developments, and then to write stories of each scenario explaining probable consequences and impacts. In this particular case the scenarios concern national and global measures to reduce stocks of animals and meat production. The effects by changes in CO₂ and methane emissions, water and land use and in production and trade (as an indicator for changes in income) were measured.

Scenario 1: Argentina measures to limit negative impacts of meat production

In the first scenario was presented Conservation programme and its impacts on domestic production and export. The consequent impacts of the scenario were discussed on basis of other researchers who analyse similar issues.

Scenario 2: Reducing meat consumption in the developed world

Decreased meat consumption was calculated based on values from 2013. Changes in water and grain demand, grain production area and CO₂ emissions production were calculated. Subsequently, impacts of decreased meat consumption were analyzed. Due to limitation to access data about exported meat from Argentina to countries of developed world, the impacts were analysed in terms of export values in US Dollars in 2013. According to UN comtrade (2014), the total exports of meat and edible meat offal by Argentina in 2013 were equal to \$ 1,890,798,836. This value was compared with values of exports in US Dollars in 2013 to developed countries.

Table 3: Exports of meat and edible meat offal by Argentina to developed countries in 2013 in US Dollars

EU - 28	\$ 533 962 533	Japan	\$ 2 609 629
Russian Federation	\$160 032 699	Kazakhstan	\$ 8 211 999
Israel	\$ 123 867 840	Switzerland	\$ 10 572 879
Republic of South Africa	\$ 22 264 503		
	Total :\$ 861 522 082		

Source: UN Comtrade. 2014.

Data for Canada, United States, Norway, Ukraine, Australia, New Zealand and for particular countries of European Union (Austria, Croatia, Estonia, Finland, Hungary, Ireland, Latvia, Poland, Slovakia, Slovenia) were not available.

From the total calculated value \$ 861 522 082 was calculated decline by 15 %, which was \$ 732 293 770. The difference between those two values was estimated as \$ 129 228 312.

5 Results

The following part includes results from own research, which comprises of desk research concentrating on analysis of the meat production, consumption and export of Argentina and worldwide, Argentinian meat policy analysis and simple models detecting national and global measures.

5.1 Desk research

The own desk research involves information on meat production, consumption and exports worldwide and in Argentina, environmental impacts of meat production and land and water demands associated with meat production in Argentina.

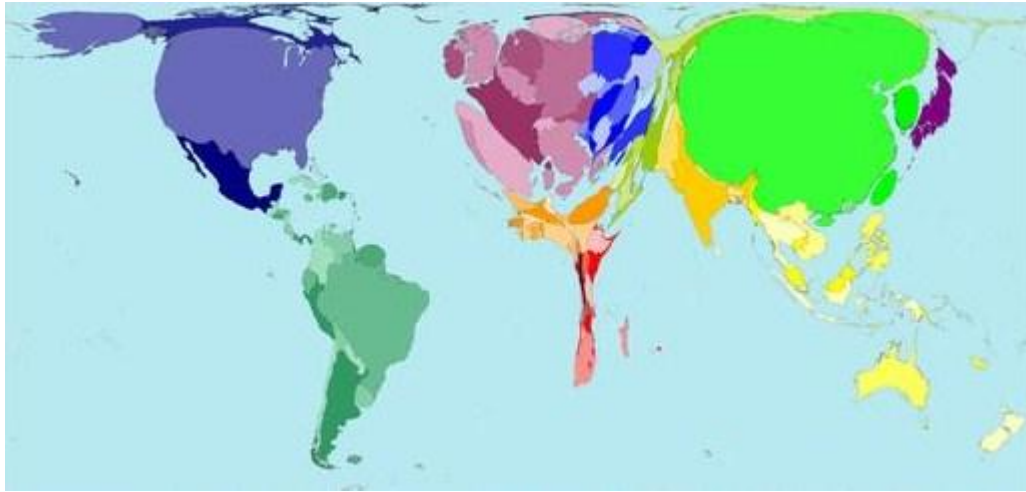
5.1.1 Analysis of meat production, consumption and exports in Argentina and worldwide

5.1.1.1 The worldwide trends of meat production

Over the last forty years has the meat production tripled and during the previous 10 years increased the production by 20 % (WorldWatch Institute, 2015). According to FAO (2015), poultry, cattle, sheep, goats and pigs are considered as species representing the main source of animal protein for humans. Mainly beef, poultry and pork are the most produced meats and poultry production sector is the fastest growing one (WorldWatch Institute, 2015).

The largest world's beef producer is The United States followed by Brazil, countries of European Union, China, India, Argentina and Australia. Countries of European Union (12.88 % of the total world's beef production), Brazil (16.85 % of the total world's beef production) and the United States (19.08 % of the total world's beef production) produce together almost half of the world's beef meat (Cook R, 2015). The biggest chicken producers are United States, Brazil and China (Wattagnet, 2014) and the biggest pork meat producers are China, United States and Germany (Wattagnet, 2012).

Figure 5: Worldwide meat production



Source: Worldmapper. 2006

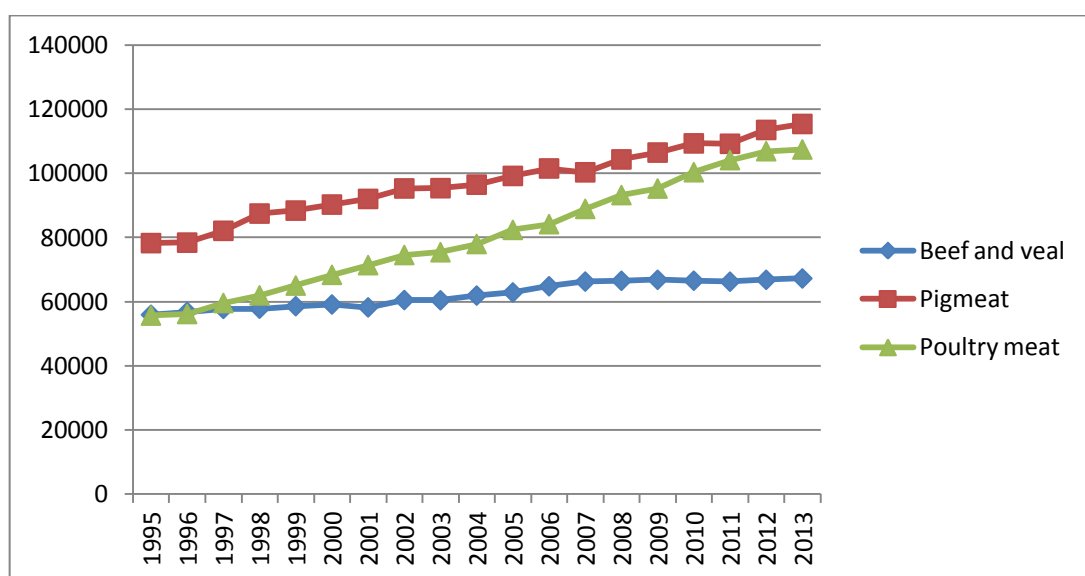
As shown in Figure 5, China, the United States, Brazil and countries of European Union belong to the largest meat producers worldwide and the total meat production of those regions covers half of all meat that is produced globally. According to Worldmapper (2015), Brazil produces twice more meat than other regions. Increasing meat production in Brazil leads to increasing land demand, which has resulted into cutting the Amazonian forests. Primarily cattle breeding is the main reason for cutting the forests and about 70 % of large and medium-sized ranches cut the forests in order to widen pastures (Fearnside, 2005). Between 1990 and 2010 Brazil lost about 55.3 million hectares of Amazon forests due to land demand for cattle breeding (Fritz, 2013). Regarding China, more than 60 % of worldwide produced soya, particularly from USA, Brazil and Argentina, is imported to China as forage intended for meat production industry (Larsen, 2012). By contrast, in Southern Asia and Central Africa has been detected the lowest meat production. Country with the lowest meat production worldwide is Equatorial Guinea.

Anyway, if the meat production and cereal production is compared, the cereal production is still significantly higher than meat production. The worldwide annual cereal production is ten times higher than produced meat.

The meat production is more likely domain of developed countries. The reason for it is, that countries of the developed part of world are distinguished by high meat consumption. But according to Gill (2007), the production in developing countries is sharply increasing in response to increasing demand (53 % per year within 1982 and

1993). The reason for it is population growth and the trend to move to urban areas. The increasing production and consumption values have been detected in Asia, especially in China due to the size of its population. According to the WorldWatch Institute will increase the demand for livestock products particularly in South Asia, but also in sub-Saharan Africa, approximately to 400 kilocalories in 2050. The demand is expected to double, compared to 200 kilocalories/person/day in 2000.

Figure 6: The world meat production in thousand tonnes in years 1995 - 2013



Source: OECD, 2014.

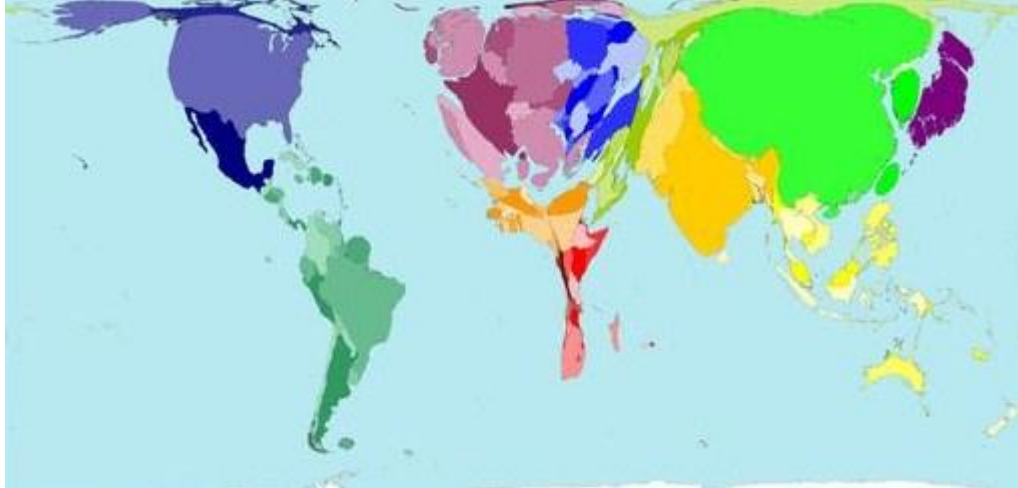
Considering the values in the Figure 6 above, especially the pigmeat and poultry meat are the the most produced items. Regarding the predictive values for years 2013 and 2023, the least difference in production is forecasted in case of beef meat and the biggest difference in the case of poultry meat. The pigmeat is nowadays the most produced meat worldwide, but it is supposed to be surpassed by poultry meat by 2023 (OECD, 2014).

5.1.1.2 The worldwide trends of meat consumption

The growth of meat consumption is closely connected to the rise of the global population, but increasing GDP (particularly in developing countries) boosts the demand even higher. With increasing financial means increases also the meat consumption (Brooks, 2013). Fifty years ago, the global meat consumption was equal to 70m tonnes, in 2007 had the meat consumption risen to amount of 268m tonnes per year. In kilograms

would be those values equal to 22kg/year per person in 1961 and 40kg/year per person in 2007.

Figure 7: Worldwide meat consumption

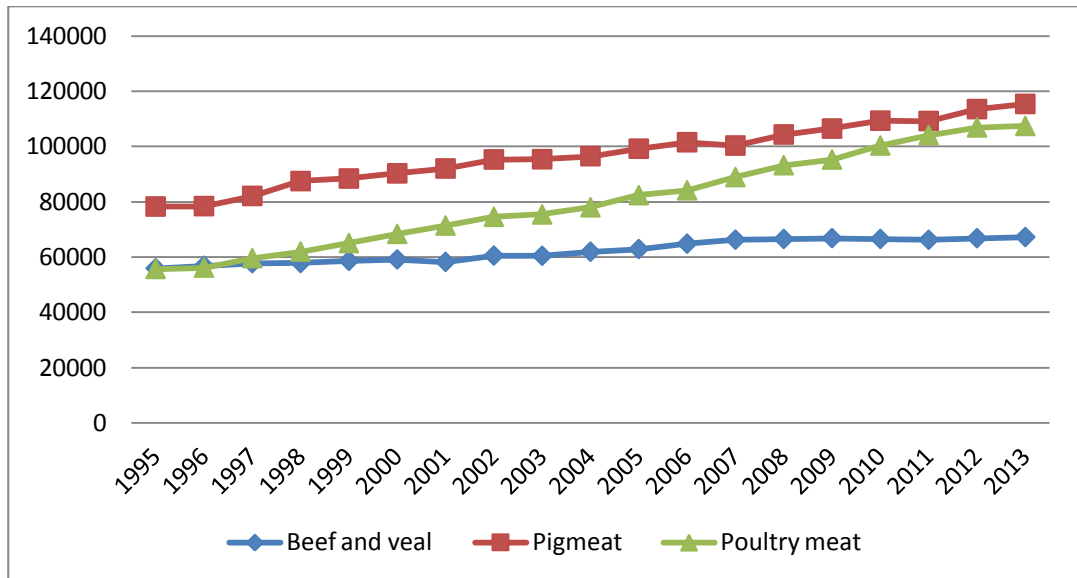


Source: Worldmapper. 2006

Especially Western European countries are characterized by the highest meat consumption per person. According to Worldmapper (2006), nine states out of ten largest meat consuming countries per person was in Western Europe in 2006. Almost one quarter of the total world meat is consumed by Chinese. The meat consumption in China doubled in comparison to USA between 1978 and 2012. In 1978 created the Chinese meat consumption (8 million tonnes) only one third of the US meat consumption (24 million tonnes). The meat consumption in China is nowadays equal to 71 million tonnes per year, whereas the annual meat consumption in USA is approximately 32 million tonnes (Larsen, 2012). The lowest meat consumption is typical for Central Africa. Nine countries out of top ten least consuming states is located in Central Africa.

In 2007 was the world average meat consumption equal to 38.7 kilos. This value was multiple exceeded in 95 countries and the three highest values of total meat consumption per person were detected in Luxembourg with 136.5 kilos, in United States with 125.4 kilos and in Australia with 121.2 kilos. (See Annex 1) In 2007 was beef and veal the most consumed meat in Argentina, pork in Austria and poultry in Kuwait. (UN, 2012).

Figure 8: The world meat consumption in thousand tonnes in years 1995 - 2013



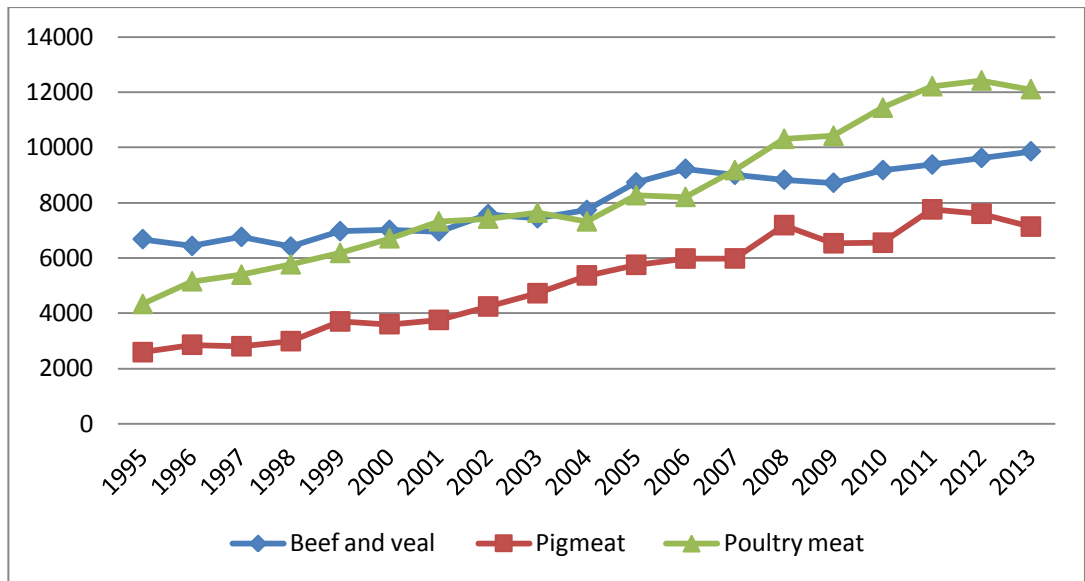
Source: OECD. 2014.

As the Figure 8 shows, nowadays pig is the most consumed meat, but the trend will be changed in the future and poultry is expected to be the most consumed meat worldwide. According to prediction of OECD (2014), the amount of consumed meat is expected to increase. Comparing the values from year 2013 and 2023, the least differences in meat intake is forecasted in the case of beef meat, whereas the biggest contrast is detected in the case of poultry meat.

5.1.1.3 The worldwide trends of meat export

Increasing meat production and consumption worldwide leads also to increasing meat export. Regarding the beef meat exports in 2014, the biggest exporter was Brazil followed by India, Australia and United States. The beef exports are expected to growth by 2 % and especially China and Hong Kong represent the majority of demand growth. In case of pork meat were United States, states of European Union and Canada considered as the biggest exporters and the exports and in case of poultry meat exports were Brazil, United States and states of European Union the biggest exporters. Both the global pigmeat and poultry meat exports are predicted to increase by 4 % in 2015. (USDA, 2014.)

Figure 9: The world meat exports in thousand tonnes in years 1995 - 2013



Source: OECD. 2014.

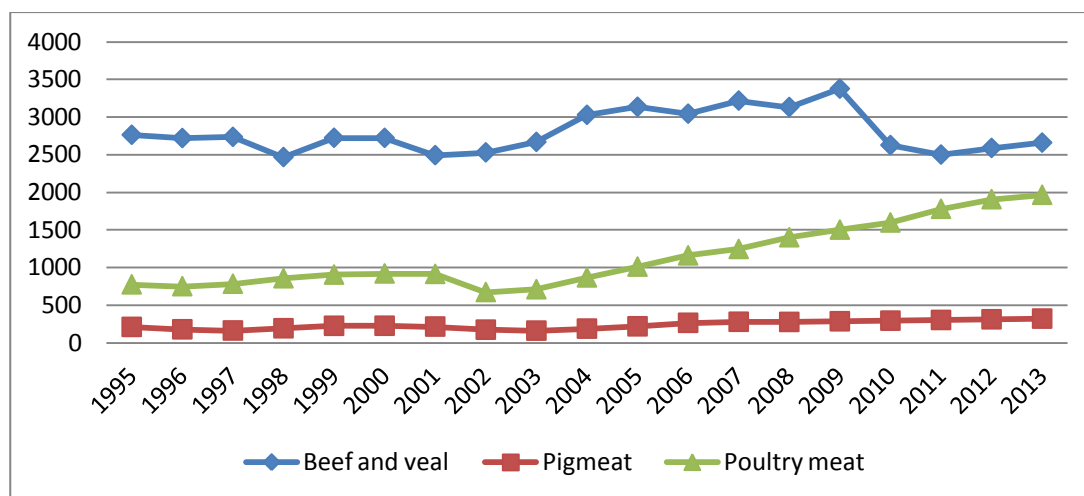
In 1995 was beef meat the most exported meat worldwide. Although the beef meat export is still increasing, it has been surpassed by poultry meat, which has become the most exported meat in 2008 and has not been surpassed yet. According to OECD (2014), the most significant growth of export is predicted in case of poultry meat sector, which is supposed to increase by 32.4 % in 2023 (compared to 2013).

5.1.1.4 Meat production in Argentina

From the historical point of view, Argentinian meat production has always been primarily concentrated on livestock industry, especially on cattle breeding. Huge parameters of the country are used as pastures and forage production area. Livestock belongs to the largest produced agricultural products (LPO, 2011).

The meat production in Argentina is a matter of large-scale production realized by cooperatives, which is a threat for the small-scale and family farmers, who perceive those large-scale producers as a competition but also as a threat because of land grabbing and rural conflicts. Small farmers, peasants and indigenous people can be displaced from the places, where they live, by expanding agricultural land and increasing demand for forage production area. Some small farmers do not own the land they use for agricultural production and land grabbers can use the opportunity of legal uncertainty (Fritz, 2013).

Figure 10: Argentina's meat production in thousand tonnes in years 1995 - 2013



Source: OECD. 2014.

According to Figure 10, the livestock industry is concentrating mostly on the beef, veal and poultry production. Especially poultry meat production has had increasing tendency since 2003, whereas in the case of the beef and veal production, changing values were detected. Although Argentina is not the main world's beef producer any more, the livestock production values are still highly significant. Regarding the pigmeat, it is not significant production item. A change was detected in 2006, when the production increased by 22 % compared to the previous year and since 2006 the production has been slightly increasing. According to OECD (2014), the total meat production including beef and veal, pigmeat and poultry meat in 2013 was equal to 4942 thousand tonnes. This value is expected to growth to 5 860 thousand tonnes in 2020, which is an increase by 19 %. The latest available forecasted data by OECD are in year 2023. In this year is the meat production supposed to reach 6 243 thousand tonnes, which represents growth by 26 %.

Beef and veal meat production

The number of cattle decreased after 2006, when the government imposed ban on beef exports, from 54 260 thousands heads to 49 590 thousands heads. In 2010 was the number of cattle equal to 49 057 thousands, which declined to 48 156 thousands in 2011. In 2012 rose the number to 49 597 thousands, in 2013 to 51 095 thousands and in 2014 to 51 545 thousands. Argentina belongs to countries with the highest number of stocks together with India (300 600 thousands, 2014), Brazil (207 960 thousands, 2014), China (103 000 thousands, 2014) and United States (87 730 thousands, 2014), (USDA, 2014).

Based on annual report from year 2013 revealed by Argentinian Ministry of Agriculture (2013), within years 1995-2009 was Argentina leading beef consumer together with United States, countries of European Union, Brasil and China. Argentina has lost this statute in 2010 after being surpassed by India. Regarding the forecast, the production is not expected to change in 2015, but there is an expected growth by 16.5 % in 2020 and by 23 % in 2023, in comparison with value in year 2013 (OECD, 2014).

Poultry meat production

The Argentina's broiler meat production is constantly increasing. Up to year 2013, the greater poultry meat producers were United States, China, countries of European Union, Mexico, India and especially Brazil was considered as the South America's markets primary poultry meat provider. This statute has gained Argentina and the production is expected to growth. Argentina's concentration on poultry meat was caused by growing demand within and outside the country along with broad feed providers. Huge investments and vertically integrated sector had direct impact on constantly increasing production, which has more than doubled during a decade and led to Argentina's statute as the eight largest world's producer. Comparing the values from 2010 and 2013, the production increased by 25 % and according to OECD (2014), in comparison with year 2013 is the value expected to increase by 14 % in 2020 and by 29 % in 2023.

Share of Argentina on the world's meat production

Regarding years 1995 – 2013, the average percentage share of Argentina on the world's beef meat production was equal to 4.50 %, on the pigmeat production 0.24 % and on the poultry meat production 1.39 %. Complete absolute and percentage values are attached as Annexe 2.

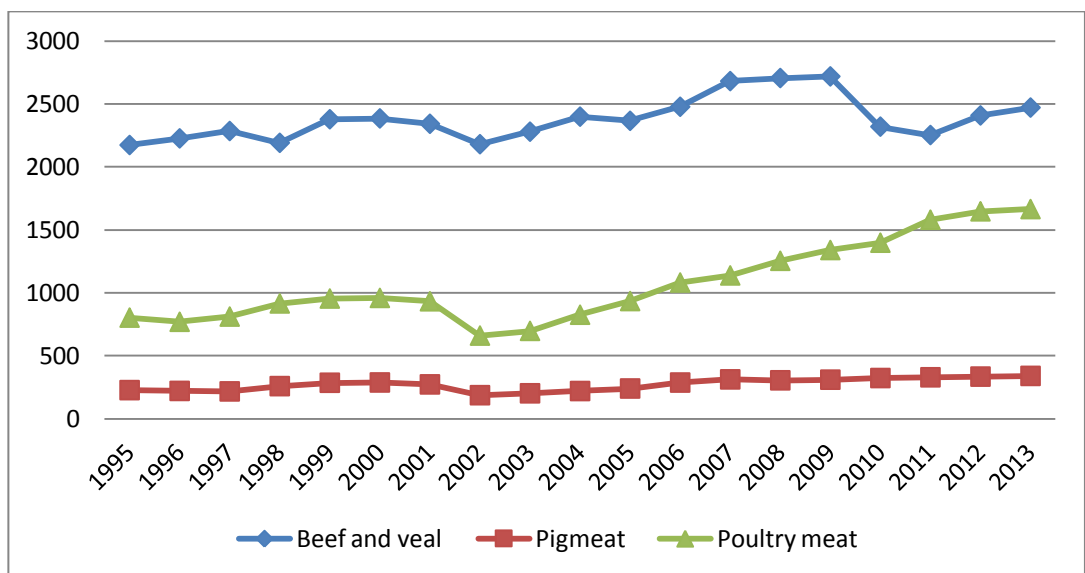
The beef and veal meat production was relatively stable till 2009 and the percentage share on the worldwide meat production was usually higher than 4.50 %. Although the values have dropped under 4 % since 2010, Argentina still belongs to the most significant beef meat producers worldwide. For example in 2013 produced Australia, India and Brazil also 4 % of the total world's production. But the biggest producers became United States (17 %) and China (10 %). The least differences were detected in the case of pork meat, which production has decreased and increased many times during the time period from 1995 to 2013, but comparing the values from the year 1995 and 2013, the values are almost the same. Based on comparison with the largest pork meat producers

(United States – 9 % and China – 47.7 % of the total world’s production) can be stated that pork meat represents no significant item in the meat production of Argentina. In case of poultry meat, the production tends to be more and more significant, except the years 2002 and 2003. Compared to the biggest poultry meat producers (United States – 18 %, Brazil – 12 % and China – 16 % of the total world production), the poultry production of Argentina was negligible compared to other countries in 2013.

5.1.1.5 Meat consumption in Argentina

Argentina belongs to countries with the highest meat consumption in the world. In 2012 was the total meat consumption (including beef and veal, pork, poultry, mutton and goat and other meat as horse, fish, etc.) 91.7 kilos per person per year and Argentina was 17th country out of 177 countries with the biggest meat consumption. At the same year was estimated, that Argentinians were with 55.1 kilos per capita the largest beef meat consumers worldwide (UN, 2012). Apart from beef meat, poultry belongs to the most consumed types of meat.

Figure 11: Argentina’s meat consumption in thousand tonnes in years 1995 - 2013



Source: OECD. 2014.

The total meat consumption in Argentina is increasing. The only significant drop was noticed in 2002 as a reaction to Argentina’s economic crisis lasting from 1999, which was caused by continuous incompetence to reduce the high public and external debts and it results into uncertain situation on market (Moreno R, 2002). The other greater drop was

monitored in 2010 in case of beef and veal meat consumption as a reaction on worldwide economic crisis. In 2009 was the the per capita beef consumption equal to 68.4 kg and the consumer price for one kilogram was 3.97 dollars. In 2010 was the beef consumption reduced to 57.5 kg per capita per year, which is drop by 16 %, and the consumer beef price increased to 6.5 dollar for one kilogram. In 2011 dropped the beef consumption even deeper to 55.5 kg per capita per year and the consumption price rose to 8.6 dollars for one kilogram (Mercado Internacional de Carnes, 2013). The price for beef grew by 63.7 %. The market crisis in 2010 and 2011 had no negative impact on poultry meat or porkmeat. Contrarily, the poultry consumption, as a cheaper substitution of beef, increased from 29.46 kg per capita per year in 2009 to 30.47 in 2010 and than by 12 % to 34.15 kg per capita per year in 2011 (OECD, 2014).

Beef and veal meat consumption

Beef consumption in Argentina used to be much higher. For example in 1956, the beef consumption per capita was equal to 222 pounds (100,8 kg), whereas in 2012 the consumption declined to 129 pounds (59kg) per person. The reason for this considerable change are higher beef prices, land moving from pastures to crops and growing vegetarian market in the country. The increasing consumption of poultry, pasta and pizza has has impact on decreasing beef consumption. Argentina's government has established program "Meat for Everyone" to support the beef industry and satisfy the Buenos Aires' beef market with affordable prices. The government's decision to increase export taxes on Argentine beef, which kept beef within the country, have helped the domestic consumption to recover from 2011, when the consumption was detected as record low. (Wessler, 2013) According to South Atlantic News Agency Merco Press (2013), the new leader in beef consumption became Uruguay with 60 kg per capita/year.

In 2011 was detected drop as a reaction to economical crisis and in 2012 surpassed Argentina Russia's beef consumption by 11 %. As it was mention above, the beef meat consumption was record low in 2011. After the government's support, the consumption increased by 6 %. In 2014 was detected decreased consumption by 1.3 %, which was reaction to decreased production. In the same year was Argentina the 5th country with the highest poultry consumption. The consumption is expected to increase by 2 % in 2020 and by 7 % in 2023, compared to 2013 (OECD, 2014).

Poultry meat consumption

Argentines have always been the largest beef consumers, but high prices for beef became one of reasons for choosing alternatives in other type of meat. The poultry meat consumption has almost doubled during the last decade and its rapid growth was moderated in 2012 as a consequence of market saturation and decline of beef prices. It led to even greater broiler meat exports. The poultry meat consumption is expected to increase by 12 % in 2020 and by 16 % in 2023, compared to 2013 (OECD, 2014).

Share of Argentina on the world's meat consumption

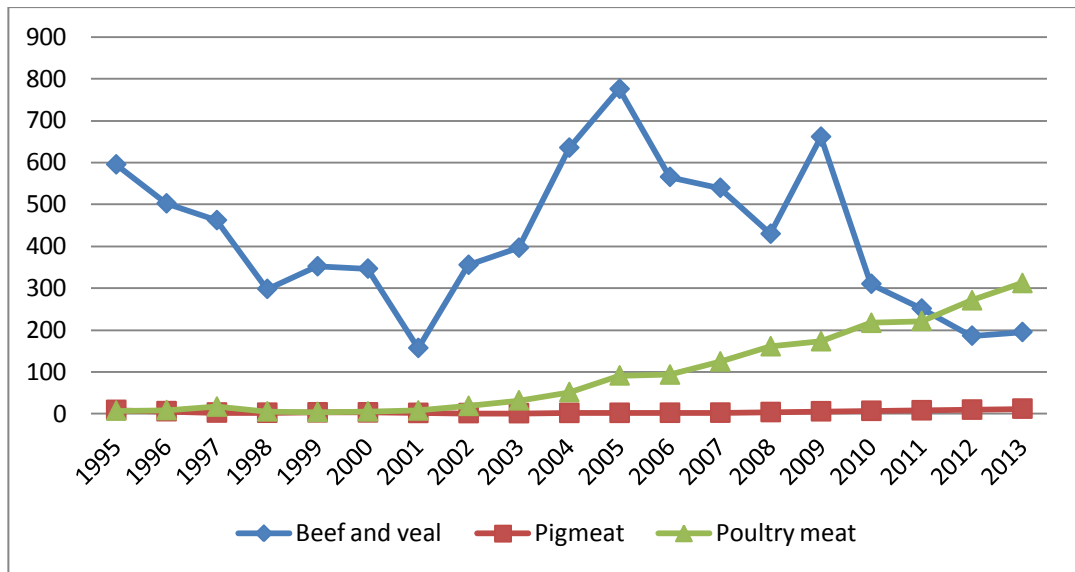
Regarding years 1995 – 2013, the average percentage share of Argentina on the world's beef meat consumption was equal to 3.87 %, on the pigmeat consumption 0.28 % and on the poultry meat consumption 1.33 %. Complete absolute and percentage values are attached as Annexe 3.

Values for beef and veal and pig meat consumption are almost the same, just slight changes have been detected. But generally, beef and pork meat consumption has represented almost the same share of the world's consumption since 1995. Compared to the United States, which belong to the largest consumer of beef, pork and poultry meat, the share of US beef consumption is 17 % and pork consumption represent share of 7 %. In case of poultry meat was the world's share of consumption almost the same, but the share has started to growth since 2011. Compared to the United States, which poultry consumption is equal to 15 % of the total world poultry consumption, the Argentina's poultry consumption is not significant item.

5.1.1.6 Argentina's meat export

Argentina has always aimed its agricultural export activities primarily on beef meat. This has changed with increasing poultry production. Nowadays, poultry meat is as significant export item as beef meat.

Figure 12: Argentina's meat export in thousand tonnes in years 1995 - 2013



Source: OECD, 2014.

The Argentinians beef export is unstable with huge fluctuations and especially after 2005 was detected huge decline due to governments restrictions. The contrast is poultry meat consumption, which is, same as production and consumption, incessantly increasing without any drops. Even in 2011 was the poultry and beef export equal and in the following two years was beef export surpassed by poultry export by 100 thousand tonnes. Pigmeat export have always been negligible.

Beef and veal export

In 1995 became Argentina the 4th biggest beef exporter, in 2004 and 2005 3rd biggest beef exporter, in 2006 4th biggest exporter, in 2007 5th biggest exporter and in 2009 4th biggest exporter (Mercado Internacionales de Carnes, 2013). Argentina, as an beef exporter, has always had an unpredictable behaviour, which was a result by broad range of circumstances as health, limited availability of investment, closing markets or restrictions.

The Argentina's statute of great beef exporter has started changing since years 2005 and 2006 due to government's restrictions, which aim was to maintain low beef price on domestic markets and significantly decreased the export activity. Whereas in 2005 was exported 750 000 tonnes of beef meat, in 2006 decreased this value by 20 % to 600 000 tonnes of beef meat (LPO, 2011). Government's restriction caused beef exports even more to fall by 53 % between 2008 and 2010 (Perkins, 2013) to 300 000 tonnes (LPO, 2011). According to president of ACEP, there are two factors negatively influencing Argentinian

beef export nowadays and those are “frozen” value of dollar to peso and the prices in the domestic market, which are higher than in the rest of the world. (LPO, 2011). The split between production and export has always been 80 % production and 20 % export, but right now, around 93 % of beef production is consumed internally and only 7 % is exported. Argentina is trying to reach the split 80:20 again through investment into genetics, introducing new breeds and production methods, which has caused increasing number of calves (Perkins, 2013). Regarding the forecasted values, the beef and veal meat export was equal to 195 thousand tonnes in 2013 and it is expected to growth by 200 % in 2020 and by 313 % in 2023.

Poultry meat export

The export's success is based on competitive prices and global demand for poultry meat, which is cheaper compared to pig meat or beef meat. Over $\frac{3}{4}$ of exports include poultry and $\frac{2}{3}$ of exports are aimed at South American countries. For example in 2012 was exported 356 000 tonnes, of which 100 000 tonnes was sold to Venezuela (MercoPress, 2012). Due to this great poultry-export-concentration became Argentina 6th world's largest exporter selling to more than 60 countries (MercoPress, 2012). More and more producers are starting to focus on broilers and it results to positive influence of industry growth (USDA, 2014).

Poultry meat the export was equal 312 thousand tonnes in 2013 and the the value is expected to rise by 66 % in 2020 and by 98 % in 2023. Whereas the beef and veal meat export is expected to growth constantly, poultry meat export is presumed to drop in 2016 and since 2017 are those values expected to growth constantly (OECD, 2014).

Share of Argentina on the world's meat exports

Regarding years 1995 – 2013, the average percentage share of Argentina on the world's beef meat export was equal to 5.37 %, on the pigmeat exports 0.09 % and on the poultry meat exports 0.93 %. Complete absolute and percentage values are attached as Annexe 4.

Meat export sector of Argentina is characterized by the largest changes, especially in case of beef and veal meat. Since 1995 has the beef export decreased from 8.92 % in 1995 to 1.98 % in 2013. During this time period were detected huge fluctuations. For example, compared to Brazil and Australia, which are one of the biggest beef exporters,

Brazil's share of total world exports was 18 % and Australia's 17 % in 2013. With the same fluctuations is also characterized the pork meat export, which is for Argentina not at all important. For example compared to United States and Canada, the share of total pork meat exports was 32 % and 18.7 %. Changes have shown in case of poultry meat exports, which have slightly increasing tendency and in 2013 represented the poultry export with 2.58 % bigger share on the total poultry exports worldwide than the beef export with 1.98 %. However, the value is still not comparable for example with poultry exports of United States and Brazil both with 31 % in 2013.

5.1.2 Economic importance and environmental impacts of meat production in Argentina

Argentina represents the third largest economy in the Latin America and food processing belongs to the largest industries (Global Edge, 2014). Meat production, primarily cattle industry, is important part of Argentinian economy. Although Argentina concentrates primarily on the domestic market (about 80% of its production is used for domestic consumption), it is still one of the most important beef supplier in global markets (McConnel, Mathews, 2008).

Table 4: Agricultural value added in percentage of GDP in years 1995 - 2013

Years	1995	1996	1997	1998	1999	2000	2001	2002	2003	
% of GDP	4.9	5.1	4.8	4.8	4.1	4.3	4.3	9.3	9.8	
Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
% of GDP	9.0	8.4	7.7	8.8	7.2	6.2	8.2	7.8	6.9	7.0

Source: World Bank. 2014.

Value added represents the net output of a particular sector after adding up all outputs and subtracting intermediate inputs (World Bank, 2014). Although the data of agricultural value added in the Table 4 include not only the sector of livestock production, but also forestry, hunting and fishing and cultivation of crops, it must be considered, that livestock production represents significant items. Compared to years 2001 and 2002, the difference of values is significant, which might be a result of ended Argentinian Great Depression, which lasted from 1999 to 2002, when the GDP decline was stopped. The Great Depression led also to peso devaluation, which caused increased competitiveness of export and increased export demand (Pettinger, 2012). The consequence of it was more

than twice larger export of meat, which also influenced the GDP growth. Another significant change was noticed in 2009, when the agricultural value added decreased to 6.2 %, which was caused by decline in soybean production, which is also significant agricultural item (Martell, 2014). Contrarily, the meat production and exports increased in 2009 (OECD, 2014).

The economic significance of meat products was calculated according to Balassa index of revealed comparative advantage. If the final value of the index calculation is higher than 1, it means that the product represents item of export specialisation.

Table 5: Meat and edible meat offal exports by Argentina and worldwide in 2013 (in US Dollars)

Commodity	Export values in US\$
Export of meat and edible meat offal by Argentina	1 890 798 836
Total exports of Argentina	76 633 913 944
Export of meat and edible meat offal excluding Argentina	121 416 744 190
Total exports excluding Argentina	17 862 681 518 417

Source: UN Comtrade. 2014.

Balassa index is equal to 3.6. Compared to the total world exports of meat and edible meat offal, Argentina has huge specialization for the export of meat. According to WTO (2014), exported agricultural products, which include also meat, created 50.8 % of the total Argentinian exports in 2013 and the main destinations were Brazil, countries of European Union, China, United States and Chile.

The following Table 6 includes index of revealed comparative advantage of Brazil, USA, Germany, Australia and Netherlands in 2013, which are according to UN comtrade (2014) the largest exporters in the selection export of meat and edible meat offal. World is taken as the reference area. Argentina is also included in order to compare the values.

Table 6: RCA index of meat and edible meat offal by selected countries in 2013

Country Commodity	Argentina	Brazil	USA	Germany	Australia	Netherlands
Meat and edible meat offal	3.6	10.0	1.6	1.0	5.1	2.7

Source of data for calculation: UN Comtrade. 2014.

According to data shown in Table 6, meat production, and particularly red meat production, is a significant export item, which counts Argentina between countries with high level of meat export specialization. It is even important to highlight the comparison of Argentina and United States. Although United States exported³ much more meat in 2013, Argentina had much higher comparative advantage.

But if all environmental impacts are taken into account, such a huge production becomes disadvantage from the environmental point of view. Increasing production is proportionally connected to increasing CO₂ production, water and fodder demand and water pollution. The fodder production causes together with other agricultural plants decline of soil fertility, which leads to lower yields in agriculture.

With increasing population and shrinking resources, some regions will not be able to produce such amount of meat to feed their inhabitants. It might be an opportunity for Argentina to gain the particular regions as its target market, but on the other hand it would mean, that more meat must be produced, which would represent increased negative impacts on environment (SCAR, 2011). In 2015 Argentina already started concentrating the trade interests on China, which indicates increasing meat demand. The only aspect that limits the expansion and larger production are current local policies and dynamics, which set export limitations and export taxes. The government provides export permits for each shipment and monitors all beef exports (USDA, 2015).

Meat industry led by cattle industry significantly contributes to the economical growth of the country, but on the hand it also contributes to methane emissions, nitrous oxide emissions and CO₂ emissions. Agricultural methane emissions are produced by animals and their waste and agricultural waste burning. Production of agricultural nitrous oxide emissions is caused by animal waste management, fertilizers usage (both synthetic and animal manure) and agricultural waste burning. (World Bank, 2014).

³ According to OECD Agricultural Outlook (2014), United States exported 7132.24 thousand tonnes of meat in 2013, whereas Argentina exported only 518.48 thousand tonnes of meat. The mentioned meat exported by both countries include only beef and veal, pigmeat and poultry meat.

Table 7: Agricultural emissions produced in Argentina between 2000 - 2010

Years	2000	2005	2008	2010
Agricultural methane emissions (% of total)	72.3	71.9	90.8	92.2
Agricultural nitrous oxide emissions (% of total)	85.7	88.9	90.8	92.2

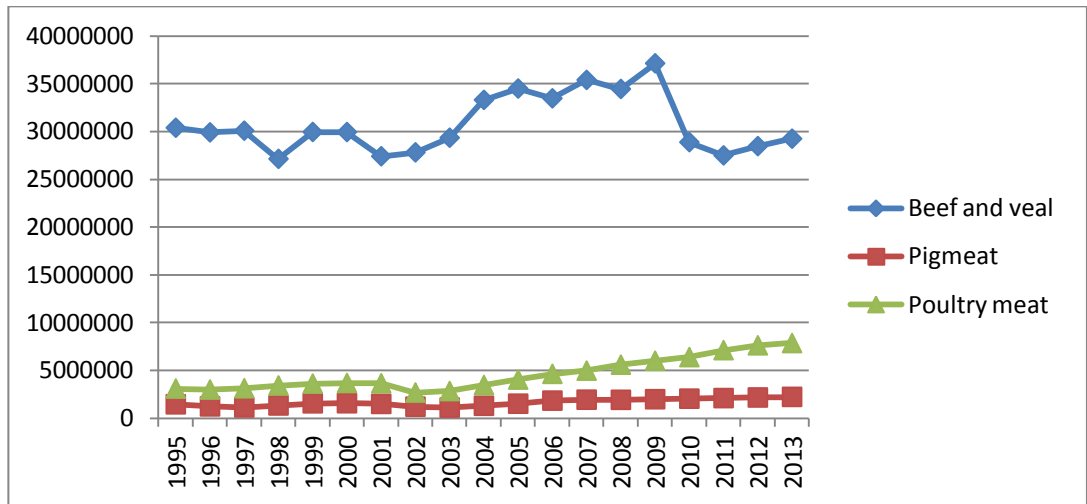
Source: World Bank. 2014.

In both cases, agriculture is majority contributor to the production of methane and nitrous oxide emissions. Primarily in case of methane emissions, huge growth was detected between years 2005 and 2008, which is relatively short time period. This value is directly proportional to the meat production, which has been increasing already since 2004. Whereas the meat production was equal to 3 864 metric tonnes in 2000, the value increased to 4 806 thousand tonnes in 2008, which is almost by 950 thousand tonnes more. The contribution of agriculture to nitrous oxide emissions was not so rapid as in case of methane emissions. The growth has been steady, but also records increasing changes in meat production.

Meat production is also a large contributor to carbon footprint CO₂. According to Carrington (2014), decreased red meat consumption would lead to larger impact in terms of cutting the carbon emissions, than giving up cars. Caro et. al (2014) reveals in his research, that over the 20 year period increased the CO₂ emission of traded meat by 19 %. The largest trade flows of emissions of traded meat were from Brazil and Argentina to Russia.

Argentina's approach to the climate change connected with greenhouse gas emissions was difficult due to several crisis in the recent years and the main aim of the government was economic recovery and growth. Anyway, Argentina reacted to climate change by signing the United Nations Framework Convention on Climate Change in 1993 and the Kyoto Protocol in 2010. In recent years has Argentina started to be more active in the issue of climate change, but those activities touch different sectors and industries apart from agricultural sector (Globe International, 2013).

Figure 13: Contribution of meat production to carbon footprint CO2 in metric tonnes in years 1995 - 2013



Sources: OECD. 2014. City University of Hong Kong. 2013.

The average value of CO2 emissions produced by beef between years 1995 and 2013 is equal to 30 756 000 metric tonnes per year, which is five times higher value than average values of both pig meat and poultry meat together. The highest values of CO2 emissions produced by meat production (including beef, pork and poultry meat) was detected in years 2007 and 2009. Those years are characterized as a peak of beef meat consumption in Argentina, which was caused by relatively low beef meat consumption prices (Ministerio de Agricultura, Ganadería y Pesco, 2013). If the total CO2 emissions are compared with CO2 emissions produced only by beef, pork and poultry meat, the average value of the total CO2 emissions production in Argentina in years 1995 – 2000 are equal to 4.0 metric tonnes per capita (World Bank, 2014) and the average value of CO2 emissions produced by meat in the same time period is equal to 1.0 metric tonnes per capita. It reveals, that the meat production contributes with one quarter to the total production of Argentinian CO2 emissions.

Methane emissions, nitrous oxide emissions and carbon dioxide (CO2) belong to gases, which expansion contributes to global warming associated with climate change (NASA, 2013). The Argentine government confesses that the country’s vulnerability to climate change is especially in the threats of floods and landslides, which are results of increased rainfall, melting glaciers and increased river flow (Globe International, 2013). According to WWF global (2012), climate change impacts in Argentina are:

- Unusual extreme weather as flooding in the Argentina Pampas (2000-2002) and hail storm in the region of Buenos Aires (2006)
- Increasing rainfalls (particularly in southwest Argentina) have a negative impact on land use, crop yields and led to increased flood tendency and intensity
- In southwest Argentina was detected decreasing trend in precipitation
- Increasing sea level is likely to have impacts on low-lying coastal areas, for example Buenos Aires coast
- Wetter conditions (particularly in southern America) have led to increased floods, but also have improved crop yields in the Pampas Region and have increased fishing opportunities

According to Latin American Studies Program (2007), Argentina faces the experience some of the most largest impacts of global warming representing melting Upsala Glacier, the heaviest rainfall in 100 years in May 2007 and snowfall in July 2007, fire outbreaks due to high temperatures and droughts, constant flooding in north Argentina, floating icebergs near Atlantic coasts and increasing incidence of tropical diseases.

5.1.3 Land and water use demand associated with Argentinian meat production

The production concentrating on the high-yield farming with feedlots is much more intensive and concentrates the cattle in one place (Hayes, 2008). In the following Table 8 was calculated the water, forage and land demand associated with meat production.

Table 8: Reliance of meat production on water, grain and land demand in years 1995 - 2013

Years	Beef and veal production		Pigmeat production		Poultry meat production				
	Water demand in million liters	Grain demand (1,000 tonnes)	Grain production area (ha)	Water demand in million liters	Grain demand (1,000 tonnes)	Grain production area (ha)	Water demand in million liters	Grain demand (1,000 tonnes)	Grain production area (ha)
1995	42 826 500	30 393	4 605 000	993 600	1 449	219 545	3 018 600	3 096	469 091
1996	42 144 500	29 909	4 531 667	844 800	1 232	186 667	2 921 100	2 996	453 939
1997	42 392 500	30 085	4 558 333	768 000	1 120	169 697	3 049 800	3 128	473 939
1998	38 238 500	27 137	4 111 667	912 000	1 330	201 515	3 334 500	3 420	518 182
1999	42 206 500	29 953	4 538 333	1 065 600	1 554	235 455	3 525 600	3 616	547 879
2000	42 191 000	29 942	4 536 667	1 070 400	1 561	236 515	3 584 100	3 676	556 970
2001	38 626 000	27 412	4 153 333	1 022 400	1 491	225 909	3 560 700	3 652	553 333
2002	39 199 500	27 819	4 215 000	820 800	1 197	181 364	2 616 900	2 684	406 667
2003	41 354 000	29 348	4 446 667	758 400	1 106	167 576	2 765 100	2 836	429 697
2004	46 934 000	33 308	5 046 667	888 000	1 295	196 212	3 377 400	3 464	524 848
2005	48 608 000	34 496	5 226 667	1 036 800	1 512	229 091	3 939 000	4 040	612 121
2006	47 166 500	33 473	5 071 667	1 257 600	1 834	277 879	4 520 100	4 636	702 424
2007	49 879 000	35 398	5 363 333	1 324 800	1 932	292 727	4 851 600	4 976	753 939
2008	48 546 000	34 452	5 220 000	1 315 200	1 918	290 606	5 460 000	5 600	848 485
2009	52 328 000	37 136	5 626 667	1 358 400	1 981	300 152	5 857 800	6 008	910 303
2010	40 703 000	28 886	4 376 667	1 396 800	2 037	308 636	6 228 300	6 388	967 879
2011	38 750 000	27 500	4 166 667	1 440 000	2 100	318 182	6 938 100	7 116	1 078 182
2012	40 114 000	28 468	4 313 333	1 483 200	2 163	327 727	7 433 400	7 624	1 155 152
2013	41 214 500	29 249	4 431 667	1 526 400	2 226	337 273	7 663 500	7 860	1 190 909

Sources of data for calculation: OECD: Agricultural Outlook (2014). Water footprint organization. 2013. Global Yield Cap Atlas. 2012.

Beef meat production represents the most water, grain and land demanding sector compared to pork meat and poultry meat production. The average water demand for beef meat industry in years 1995 – 2013 was 43 338 000 million liters, which is approximately 7.8 times higher water demand, than water demand of both the pork meat and the poultry meat production. Average water demand of pigmeat industry was 1 120 168 million liters and regarding the poultry meat, the average water demand was 4 455 032 million liters. Although 3 900 litres of water is needed to produce 1 kilo of poultry meat, which is by 900 litres less than in the production process of pig meat, the water demand of poultry meat industry in Argentina is roughly four times higher than water usage in pork meat industry, because the average poultry meat production in years 1995 – 2013 was five times higher than the average pork meat production.

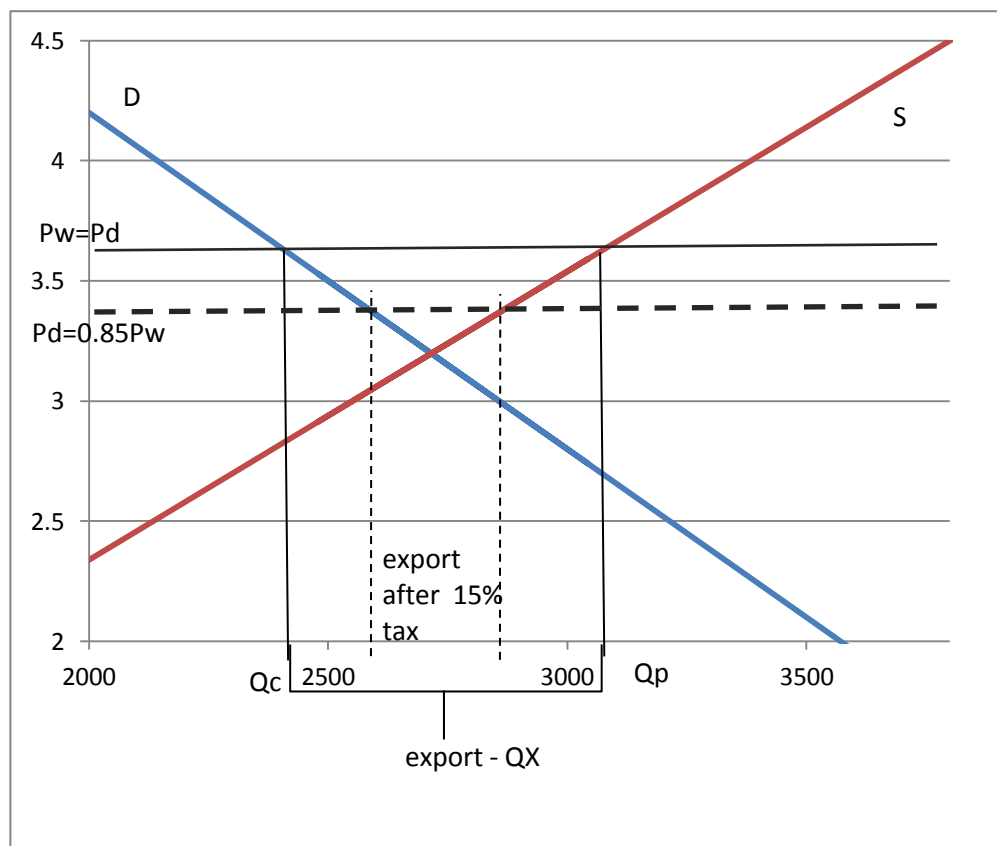
The same character have also the values of grain production and land usage for forage production. The average grain demand in 1995 – 2013 in beef production was 30 756 thousand tonnes, 1 634 thousand tonnes in pigmeat production and 4 569 thousand tonnes in poultry production, which means, that the beef production is characterized by five times higher grain usage than pork and poultry meat production together. This can be also applied to land demand for grain production, which logically means, that five times more land is needed for grain production intended for beef meat industry. If the land area used for the grain production is compared to the total agricultural land⁴ of Argentina in years 1995 - 2012, the average share of land area used for forage cultivation on the total agricultural land was 4.1 %. The average growth of the total agricultural land is 1% per year. Increasing share of agricultural land on the total area of Argentina contributes to shrinking forests and pastures. It was estimated, that Argentina lost approximately 5.2 million hectares of forests between 1990 and 2010. Also so-called indirect land-use leads to further deforestation, which represents displacement of pastures and grasslands. Farmers are forced to leave for other regions, where they start clearing forests and savanahs to transform the land into pastures (Fritz, 2013).

⁴ The agricultural land represents area, which is arable, under permanent crops and under permanent pastures. Land cultivated for forage production is also included (World Bank, 2014).

5.2 Argentinian meat policy analysis

In 2005 was Argentina the 3rd largest beef exporter. This statute has changed after the March 16th 2006, when the government decided to maintain low beef prices on domestic markets. It was reached by restrictions and ban imposition on beef exports for 180 days, followed by 15% export tax. This tax is still in force (Beefmagazine, 2013).

Figure 14: Introduction of export tax between 2006 to 2008

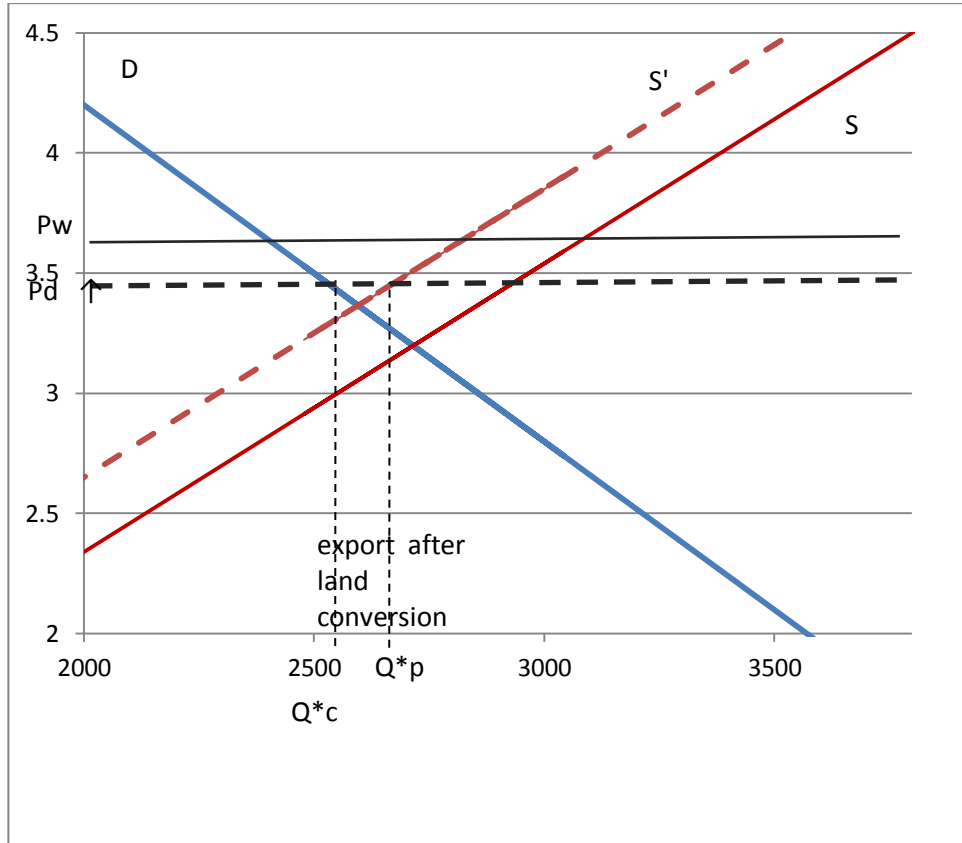


Line D represents demand of domestic consumers and line S represents supply of domestic producers. Horizontal line PW is world price for beef and line PD is domestic price for beef. As shown in Figure 14, this policy resulted not only in export decline, but also in production drop.

Instead of continuing to raise cheap beef, the pasture land was converted into arable land producing soya. The beef market has gone through depression and compared to cattle raising, it takes shorter time to produce soya. It means that soya production is characterized by huge expansion and represents significant item in export market. Since 2006, the land producing soya increased almost by 30 % in 2012 and the number of cattle declined (Beefmagazine, 2013). Arable land annually increases by 3.2 %, whereas pastures increase

only by 1 % (Zimmer, Deblitz. 2014). This refers to higher use of arable land than pastures.

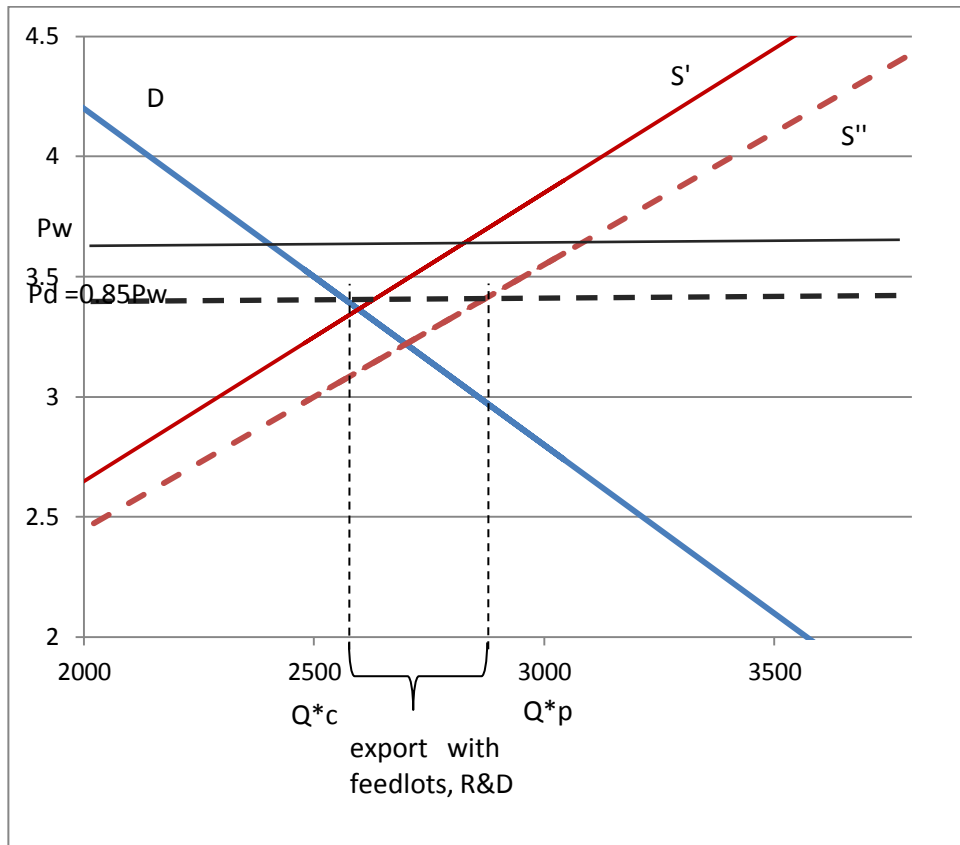
Figure 15: Conversion of pastures into arable land



Conversion of pastures into arable land has resulted in growth of domestic prices due to drop in supply. The conversion itself causes that exports decrease even more.

Farmers are not willing to convert the land back to pastures and the only way, how to recover the production and export drop is investment into more efficient technologies and beef moving into feedlots, which is supported by the government. Although the grazing meat production is perceived as a traditional agricultural activity, it is disadvantageous for farmers to apply extensive form of meat production, because intensification has made the production much faster and more profitable and the initial investment cost can be however high. In the effect, part of the traditional pastoral beef farming has been lost, part of the world market has been lost and environmental impact is much more significant. In addition, the group of consumers, who are really able to appreciate the quality and taste of beef meat produced by extensive farming form in Pampas, is relatively small. The extensive form of production lasts longer and brings lower yields, so it is much more favourable for the farmer to intensify the production.

Figure 16: Beef moving in feedlots, improvement of technologies



According to values shown in Figure 16, feedlots represent more efficient way of meat production. Land has different opportunity cost, but cattle are better fattened in feedlots. After orientation on meat production in feedlots Argentina becomes more competitive. The supply curve moves to right and down, which refers to export recovery and also to return of domestic price the 85 % of the world price. Demand line does not change.

As a consequence of above mentioned changes in meat production policies, in 2012 dropped Argentina to 11th place as a global beef exporter. The exports recovered, but in 2014 repeated Argentina the policy of export ban for 15 days, which did not help to fix the situation (Merco Press, 2014). Argentina can be used as an example, how the industry can be deteriorated and weakened by using bad policies. It shows that uncoordinated action as regulations and restrictions change nothing. Decline of Argentinian meat exports has just led to increased exports of USA, Brasil, Paraguay and Uruguay due to lower market competitiveness of Argentina.

5.3 Model projecting effects of the meat consumption development

Scenario 1: Argentina measures to limit negative environmental impacts of meat production

Background

One of possible measures to limit negative environmental impacts of meat production is internalization of impact cost, which represents a protection policy.

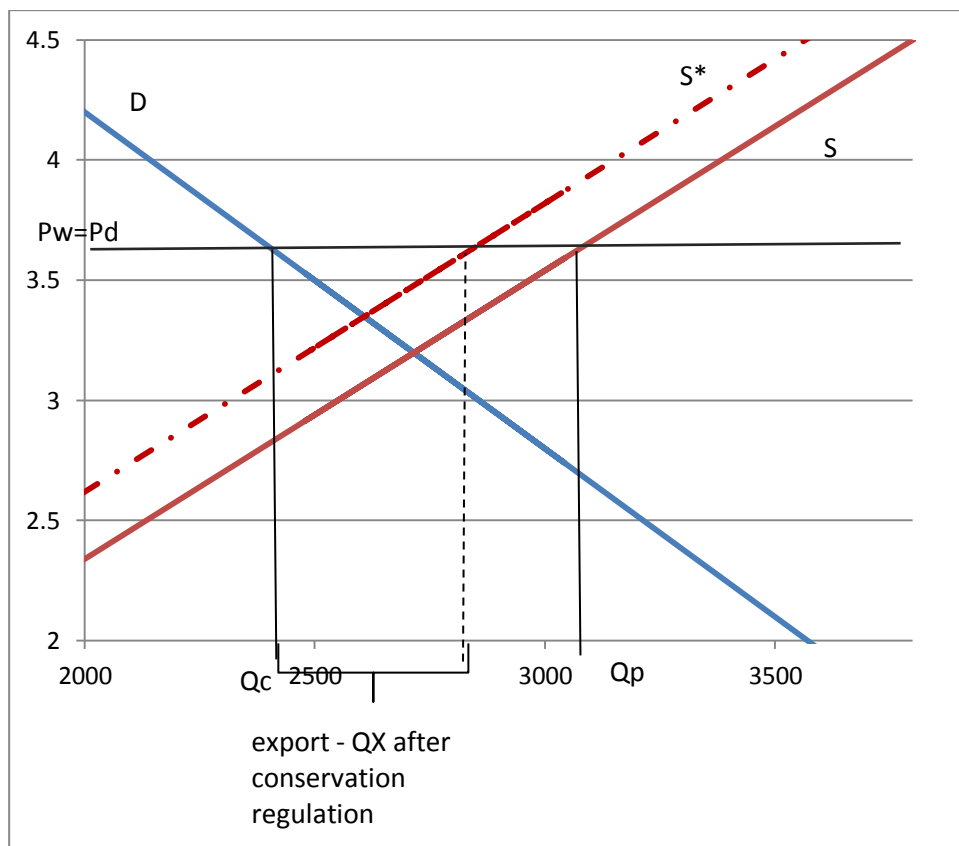
Assumption

Instead of export ban the Argentinian government introduces conservation programme with aim to reduce negative environmental impacts of meat production.

Scenario

The main idea of conservation programme is based on no support of feedlots.

Figure 17: Conservation Programme



Shifting supply curve would lead to disadvantage for exports. The situation would be similar like the introduction of export taxes. Appropriate policies would have to be

introduced in order to avoid reduction of meat production, because the meat production would be burdened with taxes and opportunity cost of crops. Apart from that, domestic consumption would not be affected, but exports would be. Producer surplus, which expresses how much the sector earns, would shrink. As a consequence of the programme, cattle herds should go down.

Conclusion

As mentioned above, the conservation programme would lead not only to export decline, but also to production decline, which would have to be avoided by creating extra policies. Drop of export would lead to fall of emissions produced by Argentinian meat industry, which would have globally no effect, because Argentina would be replaced by other exporters. Decline of meat production would weaken the position of national meat producers, which could have impacts on unemployment in this sector or increase of meat export from other countries.

Decline of meat production and exports itself has a positive impact on environment, because the negative environmental impacts (in form of large water and grain demand, grain production area demand and CO₂ emissions, water pollution, etc.) also decrease. But is still does not solve problems of negative environmental impacts caused by meat production. Decline of meat consumption is one of solutions leading to sustainable meat production (Scar, 2011), but in case of Argentina the long tradition of cattle breeding and red meat consumption must be considered and alternative solutions of sustainability must be chosen. Negative environmental impacts could be reduced by:

- Investment into processing technologies that are environmental friendly and take into account scarcity of resources and produce less losses.
- Investment into technologies that process manure and carbon dioxide into biogas, government subsidies and support of meat producers to run biogas power plants. According to Cuéllar and Weber (2008), transformation of livestock manure into biogas has great potential to meet renewable standard requirements and limit greenhouse gas. This alternative energy could be used as energy source for heat and light, which decreases energy intensity, or the electricity would be bought by the government.
- Technologies transforming faeces and manure into natural fertilizers. According to Otte (2007), one of problems connected with human health and industrial system of

livestock breeding is also usage of animals' fodder, which growth is supported by chemical fertilizers and pesticides.

- New crops variety that are not as water- and land demanding. The one of possible options are genetically modified crops. Disadvantage is that using genetically modified crops affects biodiversity and presence of GM material in food products has impact on consumers (Conner A, et. al, 2003).

Scenario 2: reducing meat consumption in developed world

Background

With increasing welfare and wages increases also the meat consumption (SCAR, 2011). Because of this fact, developed countries⁵ belong to the biggest meat consumers (See Annex 1: Meat Consumption per Person in 2007) and meat exports are oriented mainly on those countries. In 2013 was the beef and veal consumption in developed countries equal to 28 975 thousand tonnes. The pigmeat consumption was equal to 39 176 thousand tonnes and poultry meat to 41 603 thousand tonnes. The total meat consumption was 109 754 thousand tonnes (OECD, 2014).

Assumption

According to Glropolis (2014), 20 % of produced meat globally is wasted or lost. Due to tendency to perish, it is not realistic to gain 0 % wastes during the consumption process, so let's assume that 5 % of losses and wastes are standard. The total meat consumption in developed countries decreases by 15 % representing avoidable meat losses and wastes. Values from 2013 are initial.

Scenario

The water use would decrease by 119 903 800 million liters, the grain would decrease by 113 898 thousand tonnes and grain production area would decrease by 17 101 802 hectares, which would cause decline of agricultural land and the deforestation and total biodiversity loss would be slowed-down. The carbon CO₂ would decrease by 111 041 200 metric tonnes, which is equal to annual greenhouse gas emissions from

⁵ To developed countries belong: Canada, USA, EU – 28, Norway, Switzerland, Russian Federation, Ukraine, Australia, New Zealand, Israel, Japan, Kazachstan, Republic of South Africa (OECD, 2014)

23 377 095 passenger vehicles or CO2 emissions from 10 131 496 homes' energy use for one year (EPA, 2014).

Although 80 % of the whole meat production is consumed in Argentina, the rest 20 %, which is intended for export, is still such a huge amount, that makes Argentina one of the largest meat exporters worldwide and decline of meat consumption in developed world would have impact on the Argentinian trade and exports. In 2013 was the total meat export equal to \$ 1 890 798 836 and the total value of exported meat goods into developed countries was \$ 861 522 082⁶ (UN Comtrade, 2014), which represents 46% of the total meat export. Argentinian exports are from one half dependent on the meat consumption in developed countries and the value might be much higher, because values for particular developed countries were not available. If the meat consumption in developed countries decreases by 15 %, the total meat export value will decrease by \$ 129 228 312.

Conclusion

If the meat consumption in developed world decreased, the world meat price would be affected and it would decline. One half of the Argentinian meat exports are intended for developed world and decline of meat consumption would have significant impact on Argentina and its exports. The global production of emissions would not probably change, because Argentina's export activities would be replaced by some other meat exporters.

On the other hand, domestic meat consumption would not change (due to the tradition of beef meat in Argentinian diet), it might even increase as a consequence of dropped both world price and domestic price. With decreased domestic price would increase meat supply, which would affect the resource-demand. Gaining sustainable meat consumption requires resource saving technologies, structural changes in food systems and supply chains and appropriate governance.

⁶ Values of exported goods for Canada, USA, Ukraine, Australia, New Zealand and particular countries of EU (Austria, Croatia, Estonia, Finland, Hungary, Ireland, Latvia, Poland, Slovakia, and Slovenia) are not available.

6 Discussion

The research of Diploma thesis evaluated the globally known fact, that increasing meat production and consumption largely contribute to negative environmental impacts as shrinking natural resources, declining biodiversity and climate change due to production of greenhouse gas emissions. The same results were reached for example in researches of Christel Cederberg (2014), who aimed on the global consumption, or Swedish scientists Hallström, Röös and Börjesson, who aimed their research particularly on Swedish meat consumption. It refers to the reality, that this issue is not a problem of particular areas or regions, but the issue represents a global problem.

Meat production

Considering the fact, that much larger amount of grain and water needed for cattle breeding will be necessary for feeding an extra 2 billion people by 2050, the sustainable way of meat production and consumption is the only way, how to insure the food security in the future. Growing income in developing countries will influence the consumers' diets and more protein rich food will be included, which will also increase the energy demand. The world's capacity for food production is limited, which represents a threat, that food demand will not be met in 2050. This issues would lead to more hunger and political instability (SCAR, 2011). It is also important to mention, that increasing population is facing primarily the developing part of the world. Especially in India and China, which also experience economical growth. Almost two thirds of the world population is expected to live in Asia in 2025 (SCAR, 2011). If more Asians will be able to afford to eat more meat due the economical expansion and increasing wages, the impacts will be tremendous.

Already nowadays, particularly meat production surpasses environmental and resource limits in many regions, which stresses the necessity of transition to sustainable meat production. The success of the transition is addicted to the investment into technological innovations, which would make the meat production more efficient and at the same time, environmental aspects and scarcity of resources would be taken into account. Prof Gidon Eshel claims, that „*cutting subsidies for meat production would be the least controversial way to reduce its consumption.*“ (Carrington, 2014). Although the government policies can reduce the environmental impacts, the meat production is one of the Argentinian strongest sectors, which is supported by government, so it is not in the

economical interest of the government to apply policies leading to the decline of meat consumption.

Mainly the message for consumers should be clear and strong. Basically, consumers play in this chain the biggest role and their decision has huge influence. According to economical laws, offer and demand react on themselves and influence themselves. If the demand for meat decreases, the meat production also decreases. The main issue of this problem is the consumers' information about environmental issues connected to meat production. The awareness and knowledge about environmental impacts are influenced by level of education and access to information. According Yen (2008), the dietary knowledge influences the meat consumption patterns and leads to decreasing consumption of beef and pork, but does not affect poultry or fish consumption. Vermeri and Verbeke (2006) claim, that the public interest in food sustainability grows and the attitude of consumers are mainly positive, but the consumption patterns are not the same with consumption attitudes. Results of the of the European Commission Research (SCAR, 2011) show, that elements such as the food industry, the retail sector and the media are key components in changing consumer habits.

Scarcity of resources

There are really close connections between particular scarcities, especially between climate change, biodiversity and water. Irrigation and water demand used for meat production surpasses the replenishment of water sources (SCAR, 2011). Each continent is affected by water scarcity and this problem has become one of the biggest issues, the world has to face, because water demand has been growing more than twice than the the population growth. Although there is no global water scarcity, the number of regions and areas, that are facing the shortage of water resources, is increasing. Although there is enough water for population of 7 billion people, too much water is polluted, unsustainably managed or wasted (UN Water, 2014). Meat losses and wastes represent roughly 20 % of the whole meat production, which means, that also 20 % of water used for meat production is wasted. There is much more food in supermarket shelves, than people are able to consume. Nevertheless, the meat production is expected to increase, although huge amount of produced meat, for which large amount of resources will be used, will never reach the final consumer.

Meat consumption and health issues

According to Scar (2011) overconsumption of meat, which is typical for current population, leads to mass health problems. Meat consumption is necessary for its nutrients such as iron, zinc, selenium, fatty acids and vitamins, which have direct positive impact on health and longevity (Williams P, 2007, Kappeler, 2013,) and its low intake is associated with a significant decrease in risk of death. From the health point of view it is not necessary that developed countries consume such a quantity of meat. Authors Ashaye, Gaziano and Djoussé examined that higher red meat consumption has positive impact on increased risk of heart failure. The higher risk of heart disease due to red meats consumption was also supported by American Heart Association, which recommended to consume more white meats.(Williams P., 2007).

7 Conclusion

The meat production and consumption in Argentina is expected to grow and although the meat exports have slightly decreased in previous years, Argentina still belongs to one of the biggest exporters worldwide. Argentines are the largest beef consumers: 80 % of the total production is consumed in the country and 20 % is exported. But since 90's has the poultry meat become more significant meat both in the domestic and export market. Agriculture and mainly meat industry represents larger CO2 emissions contributor than transportation, which influence the climate change, and apart from that largely contributes to biodiversity loss and shrinking of natural resources. On the other hand, meat industry is a really important sector in Argentina due to its significant contribution to Argentinian economy, so it is in interest of the government to keep increasing meat production. Especially export of red meat represents significant comparative advantage, but the exports have decreased since 2006 due to imposing ban on exported meat in order to maintain low beef prices in domestic market. This uncoordinate policy has weakened the Argentinian exports and cattle industry, which has led to increased orientation from beef industry to soya production. It has resulted in support of feedlots, which has more serious impacts on environment. To meet sustainable meat production, resource saving technologies, structural changes in food systems and supply chains and appropriate governance are required.

The main idea, the diploma thesis was dealing with, was concentrating on sustainable meat consumption. The thesis contributed with its research to environmental issues and its solving as an example, which can be applied to the whole world. The complete view on the development of meat production, consumption and exports in Argentina and its impacts on the environment was provided. This diploma thesis could be used as an initial clue for another research concentrating for example on awareness of Argentinian meat consumers about environmental impacts of meat production, because the initial impulse to decline of meat production and sustainable meat consumption is on the side of consumers.

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Annexes

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| Annex 1 | Meat Consumption per capita in 2007 |
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Annex 1: Meat Consumption per capita in 2007

Rank	Country	Beef	Pork	Poultry	Mutton and goat	Other	Total per person
1	Luxembourg	43.8	45.5	39.8	1.7	5.8	136.5
2	USA	42.1	30.3	51.8	0.5	0.7	125.4
3	Australia	43.5	23.0	39.3	14.3	1.1	121.2
4	New Zealand	31.8	22.7	34.4	23.1	3.7	115.7
5	Spain	14.9	60.9	27.3	4.5	2.5	110.2
6	French Polynesia	40.3	13.6	46.5	5.1	3.4	108.9
7	Austria	17.8	66.0	17.5	1.0	0.8	103.1
8	Israel	27.1	2.6	67.9	1.4	0.0	99.1
9	Canada	32.8	27.3	37.4	1.2	0.0	98.7
10	Bahamas	19.5	24.8	47.2	5.8	0.8	98.1
11	Denmark	26.6	49.5	18.2	1.2	2.3	97.8
12	Kuwait	2.4	0.0	75.7	18.2	1.0	97.4
13	Saint Lucia	13.1	21.8	56.9	3.5	0.0	95.4
14	Ireland	23.9	36.7	25.9	4.8	2.7	94.1
15	Iceland	12.2	21.0	26.0	24.7	10.1	94.0
16	Portugal	18.3	45.1	25.4	3.0	1.1	92.9
17	Argentina	55.1	6.8	26.8	1.4	1.7	91.7
18	Italy	24.0	44.7	15.8	1.4	5.4	91.4
19	France	26.9	31.7	21.1	3.3	5.7	88.7
20	Malta	21.0	36.8	24.4	1.3	5.0	88.5
21	Germany	13.2	55.6	15.5	0.7	2.7	87.7
22	UK	22.0	27.9	29.2	6.1	0.7	85.8
23	Antigua and Barbuda	10.8	9.9	58.0	3.5	3.2	85.4
24	Czech Republic	8.0	46.6	24.6	0.2	5.8	85.2
25	Slovenia	21.4	41.0	19.9	1.1	0.5	83.8
26	Serbia	8.5	64.8	7.0	2.0	0.0	82.3
27	Belgium	19.4	33.9	25.1	1.7	2.2	82.3
28	Bermuda	27.7	19.0	30.5	4.8	0.2	82.3
29	Cyprus	5.7	39.8	26.6	7.6	2.4	82.1
30	Netherlands Antilles	3.6	20.5	54.9	2.1	0.6	81.7
31	Brazil	37.2	11.0	31.7	0.6	0.1	80.6
32	Samoa	11.0	22.1	34.5	13.0	0.0	80.6
33	Hungary	4.3	47.2	27.5	0.1	1.0	80.1
34	Sweden	24.0	36.4	14.8	1.2	2.3	78.7
35	Chile	22.0	20.7	34.3	0.7	0.3	77.9
36	Lithuania	7.4	44.4	24.9	0.2	0.1	77.0
37	Barbados	14.5	8.3	42.2	11.6	0.0	76.6
38	Poland	4.7	51.2	20.3	0.0	0.2	76.4
39	Saint Vincent and the Grenadines	8.5	13.4	52.3	0.9	0.1	75.2
40	Greece	18.1	27.1	13.6	13.7	2.3	74.8
41	Switzerland	20.5	34.3	15.0	1.6	2.2	73.6
42	Finland	18.6	34.2	17.2	0.5	1.9	72.4
43	Belarus	21.9	32.3	17.8	0.1	0.3	72.2
44	Netherlands	18.4	32.7	14.9	0.9	4.3	71.3
45	Saint Kitts and Nevis	9.5	5.3	47.8	2.2	4.2	69.0
46	United Arab Emirates	7.0	NA	49.2	8.8	3.7	68.7
47	Mongolia	16.2	0.2	0.5	40.7	10.4	68.0
48	Kazakhstan	26.3	15.1	13.3	8.0	4.4	67.2
49	Brunei Darussalam	5.7	5.9	52.7	2.1	0.0	66.4
50	Dominica	11.9	18.3	33.8	1.4	0.1	65.4
51	Norway	20.5	23.1	14.9	5.6	1.4	65.4
52	Jamaica	5.3	3.8	52.7	3.0	0.1	64.7
53	Romania	7.7	31.9	19.3	2.5	1.3	62.7
54	Mexico	17.9	13.4	29.0	1.1	0.9	62.3

55	Latvia	8.4	31.2	20.5	0.3	0.3	60.7
56	Russian Federation	17.6	18.0	22.1	1.2	1.4	60.3
57	Panama	18.4	9.8	30.6	0.0	1.3	60.0
58	Gabon	4.0	7.3	28.4	1.4	17.7	58.8
59	Estonia	13.8	26.7	17.3	0.5	0.5	58.8
60	Slovakia	6.1	33.1	18.0	0.1	1.4	58.8
61	New Caledonia	15.6	14.8	24.7	2.3	0.1	57.5
62	Ecuador	16.9	13.9	24.4	0.7	0.6	56.6
63	Republic of Korea	11.3	31.4	13.3	0.1	0.2	56.4
64	Venezuela	21.0	6.0	28.8	0.3	0.0	56.1
65	Dominican Republic	10.6	8.1	36.7	0.1	0.0	55.5
66	China	4.7	33.3	12.0	2.9	1.1	54.1
67	Grenada	6.4	12.2	32.6	1.2	1.4	53.8
68	Saudi Arabia	5.9	NA	39.3	5.4	1.7	52.3
69	Trinidad and Tobago	5.9	9.0	34.3	2.4	0.1	51.7
70	Lebanon	19.5	2.3	26.6	3.0	0.0	51.5
71	Suriname	7.3	8.1	34.6	0.1	1.0	51.1
72	The former Yugoslav Republic	13.5	15.3	19.4	1.8	0.5	50.4
73	Croatia	8.6	26.9	12.8	1.1	0.7	50.2
74	Costa Rica	15.9	9.6	23.7	0.0	0.0	49.3
75	South Africa	16.5	3.6	25.1	3.7	0.3	49.2
76	Paraguay	13.0	26.2	8.2	0.7	0.5	48.5
77	Malaysia	5.9	7.6	34.0	0.7	0.0	48.1
78	Bolivia (Plurinational State of)	17.8	11.4	14.8	2.2	0.9	47.1
79	Albania	18.3	11.7	9.8	7.1	0.0	47.0
80	Japan	8.7	20.2	17.3	0.2	0.2	46.5
81	Montenegro	8.3	31.2	5.3	1.1	0.0	46.0
82	Belize	6.3	13.4	26.1	0.1	0.0	45.9
83	Mauritius	6.2	2.8	31.5	4.0	0.8	45.4
84	Bulgaria	5.0	18.0	20.0	1.8	0.5	45.3
85	Ukraine	11.4	15.3	17.4	0.3	0.6	45.0
86	Fiji	10.2	4.6	18.7	10.6	0.1	44.2
87	Jordan	9.4	0.0	28.1	6.0	0.1	43.7
88	Colombia	17.1	4.2	21.7	0.3	0.2	43.6
89	Uruguay	15.2	9.3	14.1	3.4	1.2	43.2
90	Turkmenistan	20.1	0.1	2.6	19.5	0.2	42.4
91	Cape Verde	2.9	21.1	15.6	1.8	0.1	41.5
92	Viet Nam	3.7	30.0	7.0	0.1	0.0	41.0
93	Kiribaty	6.0	10.4	23.4	0.9	0.3	40.9
94	Guyana	2.9	2.6	33.7	1.1	0.0	40.3
95	Cuba	5.5	17.9	14.3	1.0	0.1	38.8
96	World	9.5	14.9	12.5	1.9	0.0	38.7
97	Honduras	10.4	4.9	21.6	0.0	0.0	37.0
98	Armenia	16.0	8.0	10.6	2.4	0.0	37.0
99	Kyrgyzstan	14.7	5.5	4.0	8.8	2.2	35.2
100	Vanuatu	11.0	16.1	6.5	0.2	0.0	33.8
101	Seychelles	10.2	5.5	14.0	3.1	0.7	33.6
102	Iran (Islamic Republic of)	6.3	0.0	19.9	6.9	0.2	33.3
103	Namibia	11.7	3.1	7.7	5.8	4.3	32.5
104	Djibouti	18.8	0.3	6.9	5.5	0.9	32.4
105	El Salvador	9.4	4.1	18.3	0.0	0.0	31.8
106	Philippines	4.0	18.9	8.3	0.6	0.2	31.8
107	Central African Republic	18.3	3.2	1.1	3.1	6.0	31.7
108	Mauritania	8.0	0.0	3.3	12.3	7.9	31.7
109	Timor-Leste	1.6	9.2	5.2	0.4	15.1	31.5
110	Myanmar	3.4	8.8	17.1	0.6	0.0	29.8
111	Libya	5.1	0.0	16.6	6.2	0.6	28.5
112	Swaziland	19.3	1.4	5.4	2.1	0.3	28.4

113	Thailand	4.3	12.8	10.8	0.0	NA	28.0
114	Tunisia	6.0	NA	13.5	6.7	0.9	27.2
115	Guatemala	6.0	4.9	15.8	0.1	0.2	27.0
116	Georgia	8.8	8.2	8.6	0.9	0.3	26.8
117	Republic of Moldova	1.3	12.6	12.0	0.5	0.3	26.7
118	Maldives	5.0	1.0	16.9	0.7	2.7	26.3
119	Nicaragua	7.0	2.3	16.4	0.0	0.4	26.0
120	Uzbekistan	20.8	0.9	1.1	3.1	0.0	25.8
121	Turkey	6.1	0.0	14.7	4.5	0.0	25.4
122	Morocco	5.7	0.0	13.6	4.6	1.2	25.2
123	Botswana	9.9	0.3	3.6	3.9	6.7	24.4
124	Niger	13.8	0.1	0.8	6.4	3.2	24.3
125	Syrian Arab Republic	3.4	0.0	9.3	11.1	0.2	24.0
126	Egypt	11.9	0.0	8.6	0.8	1.7	23.0
127	Congo	1.5	3.0	9.6	0.5	7.5	22.0
128	Bosnia and Herzegovina	7.9	5.3	7.6	0.5	0.0	21.3
129	Azerbaijan	8.6	0.8	6.7	5.1	0.0	21.3
130	Peru	4.1	3.3	11.1	0.9	1.2	20.7
131	Angola	6.3	4.5	8.3	0.6	0.4	20.2
132	Algeria	5.7	0.0	7.9	6.2	0.3	20.1
133	Sudan	8.4	NA	0.7	8.2	2.4	19.7
134	Mali	7.9	0.2	2.7	5.5	2.8	19.1
135	Lao People's Democratic Republic	7.1	7.8	3.4	0.2	0.0	18.5
136	Lesotho	5.2	3.0	3.6	2.7	3.4	17.8
137	Cambodia	5.2	9.7	1.9	0.0	0.0	16.9
138	Yemen	3.4	0.0	9.7	3.6	0.0	16.7
139	Zimbabwe	8.3	2.2	4.5	1.2	0.0	16.3
140	Burkina Faso	7.7	2.6	2.2	3.1	0.6	16.2
141	Kenya	11.9	0.4	0.6	2.1	1.2	16.1
142	Benin	2.9	0.7	10.7	0.9	0.8	15.9
143	Guinea-Bissau	3.8	8.6	1.6	1.4	0.0	15.4
144	Madagascar	7.1	3.4	3.6	0.5	0.2	14.8
145	Democratic People's Republic of Korea	0.9	7.4	1.9	0.6	3.8	14.5
146	Pakistan	8.2	0.0	3.4	2.4	0.1	14.1
147	Senegal	5.4	1.0	3.2	3.1	1.2	14.0
148	Sao Tome and Principe	1.4	3.9	8.4	0.2	NA	13.8
149	Haiti	4.5	4.4	3.3	0.7	0.8	13.8
150	Ghana	2.0	0.7	5.1	1.3	4.5	13.6
151	Comoros	2.9	0.0	9.5	0.8	0.0	13.3
152	Cameroon	5.1	1.0	1.8	1.7	3.4	13.1
153	Côte d'Ivoire	2.2	0.8	1.3	0.6	8.2	13.0
154	Chad	8.3	0.1	0.5	3.7	0.5	13.0
155	Tajikistan	5.4	1.7	0.9	4.6	0.0	12.6
156	Indonesia	1.9	2.6	5.8	0.5	0.0	10.8
157	Solomon Islands	4.1	4.9	1.5	0.1	0.0	10.6
158	Liberia	0.3	2.4	4.6	0.4	2.5	10.2
159	Uganda	3.5	3.5	1.2	1.1	0.6	9.9
160	Togo	1.7	1.6	4.4	1.4	0.8	9.9
161	Nepal	6.9	0.6	0.6	1.7	0.0	9.7
162	Gambia	2.6	0.5	4.7	1.0	1.0	9.7
163	Zambia	4.9	0.9	3.0	0.7	0.0	9.5
164	United Republic of Tanzania	6.0	0.3	1.1	1.0	0.4	8.9
165	Nigeria	2.0	1.4	1.7	2.8	0.8	8.7
166	Guinea	5.1	0.2	1.1	1.4	0.6	8.5
167	Ethiopia	4.7	0.0	0.6	1.9	1.3	8.4
168	Mozambique	1.3	4.5	1.5	1.0	0.0	8.4
169	Sierra Leone	1.4	0.6	3.1	0.5	1.8	7.4

170	Sri Lanka	1.4	0.1	5.1	0.1	0.0	6.7
171	Eritrea	3.5	NA	0.4	2.6	0.2	6.6
172	Malawi	2.0	1.8	1.1	1.3	0.0	6.3
173	Rwanda	2.4	0.7	0.3	0.7	1.5	5.5
174	Burundi	1.7	1.5	0.9	1.0	0.1	5.1
175	Democratic Republic of theCongo	0.5	0.4	1.0	0.3	2.4	4.7
176	Bangladesh	1.3	0.0	1.2	1.4	0.1	4.0
177	India	1.5	0.4	0.6	0.6	0.1	3.2

Source: UN food and Agriculture Organisation. 2012.

Annex 2: Meat production worldwide and in Argentina in years 1995 – 2013 in thousand tonnes and in percentage

Years	Beef and veal				Pigmeat				Poultry Meat			
	World		Argentina		World		Argentina		World		Argentina	
1995	55926	100%	2763	4.94%	78263	100%	207	0.27%	55678	100%	774	1.39%
1996	56823	100%	2719	4.79%	78409	100%	176	0.22%	56169	100%	749	1.33%
1997	57763	100%	2735	4.74%	82098	100%	160	0.19%	59588	100%	782	1.31%
1998	57821	100%	2467	4.27%	87477	100%	190	0.22%	61967	100%	855	1.38%
1999	58605	100%	2723	4.65%	88398	100%	222	0.25%	65034	100%	904	1.39%
2000	59130	100%	2722	4.60%	90277	100%	223	0.25%	68379	100%	919	1.34%
2001	58223	100%	2492	4.28%	92035	100%	213	0.23%	71402	100%	913	1.28%
2002	60521	100%	2529	4.18%	95296	100%	171	0.18%	74553	100%	671	0.90%
2003	60436	100%	2668	4.41%	95378	100%	158	0.17%	75415	100%	709	0.94%
2004	61913	100%	3028	4.89%	96490	100%	185	0.19%	77989	100%	866	1.11%
2005	62885	100%	3136	4.99%	99198	100%	216	0.22%	82386	100%	1010	1.23%
2006	64820	100%	3043	4.70%	101528	100%	262	0.26%	84161	100%	1159	1.38%
2007	66270	100%	3218	4.86%	100333	100%	276	0.28%	88930	100%	1244	1.40%
2008	66523	100%	3132	4.71%	104344	100%	274	0.26%	93233	100%	1400	1.0%
2009	66826	100%	3376	5.05%	106481	100%	283	0.27%	95277	100%	1502	1.58%
2010	66534	100%	2626	3.95%	109340	100%	291	0.27%	100360	100%	1597	1.59%
2011	66235	100%	2500	3.77%	109218	100%	300	0.27%	104131	100%	1779	1.71%
2012	66818	100%	2588	3.87%	113536	100%	309	0.27%	106913	100%	1906	1.8%
2013	67241	100%	2659	3.95%	115393	100%	318	0.28%	107448	100%	1965	1.83%

Sources: OECD. 2014.

Annex 3: Meat consumption worldwide and in Argentina in years 1995 – 2013 in thousand tonnes and in percentage

Years	Beef and veal				Pigmeat				Poultry meat			
	World		Argentina		World		Argentina		World		Argentina	
1995	55587	100%	2174	3.91%	78129	100%	227	0.29%	55598	100%	803	1.44%
1996	55918	100%	2227	3.98%	78133	100%	221	0.28%	55508	100%	770	1.39%
1997	57318	100%	2285	3.99%	82067	100%	217	0.26%	59264	100%	812	1.37%
1998	57828	100%	2191	3.79%	87485	100%	259	0.30%	61272	100%	916	1.49%
1999	58504	100%	2378	4.07%	87905	100%	286	0.33%	64106	100%	955	1.49%
2000	58740	100%	2385	4.06%	89752	100%	288	0.32%	67590	100%	960	1.42%
2001	57645	100%	2342	4.06%	91656	100%	273	0.30%	70892	100%	933	1.32%
2002	60010	100%	2180	3.63%	94915	100%	187	0.20%	73988	100%	660	0.89%
2003	59762	100%	2280	3.81%	94901	100%	202	0.21%	75196	100%	698	0.93%
2004	61048	100%	2399	3.93%	95812	100%	220	0.23%	77152	100%	826	1.07%
2005	61653	100%	2366	3.84%	98476	100%	240	0.24%	81660	100%	935	1.14
2006	63496	100%	2478	3.90%	100901	100%	287	0.28%	83729	100%	1082	1.29%
2007	65778	100%	2681	4.08%	99751	100%	313	0.31%	88718	100%	1138	1.28
2008	66171	100%	2706	4.09%	104046	100%	305	0.29%	93551	100%	1254	1.34
2009	66348	100%	2719	4.10%	106067	100%	310	0.29%	96145	100%	1340	1.39%
2010	65936	100%	2320	3.52%	108980	100%	323	0.30%	100347	100%	1398	1.39
2011	65690	100%	2253	3.43%	108469	100%	329	0.30%	104035	100%	1581	1.52
2012	66197	100%	2409	3.64%	112995	100%	335	0.30%	106789	100%	1647	1.54%
2013	66627	100%	2471	3.71%	115229	100%	340	0.30%	107310	100%	1665	1.55%

Sources: OECD. 2014.

Annex 4: Meat exports worldwide and in Argentina in years 1995 – 2013 in thousand tonnes and in percentage

Years	Beef and veal				Pigmeat				Poultry meat			
	World		Argentina		World		Argentina		World		Argentina	
1995	6677	100%	595	8.92%	2583	100%	9	0.34%	4330	100%	7	0.16%
1996	6429	100%	502	7.81%	2853	100%	6	0.20%	5150	100%	8	0.16%
1997	6756	100%	462	6.84%	2798	100%	3	0.09%	5389	100%	17	0.31%
1998	6406	100%	298	4.65%	2982	100%	2	0.07%	5765	100%	5	0.09%
1999	6964	100%	352	5.05%	3696	100%	3	0.08%	6177	100%	4	0.06%
2000	7009	100%	346	4.94%	3598	100%	3	0.08%	6705	100%	5	0.08%
2001	6960	100%	157	2.25%	3751	100%	2	0.04%	7322	100%	7	0.10%
2002	7580	100%	355	4.69%	4238	100%	1	0.03%	7418	100%	18	0.25%
2003	7431	100%	396	5.33%	4717	100%	1	0.02%	7634	100%	32	0.42%
2004	7730	100%	635	8.22%	5362	100%	2	0.03%	7318	100%	51	0.70%
2005	8729	100%	776	8.89%	5745	100%	2	0.03%	8267	100%	91	1.10%
2006	9222	100%	565	6.13%	5973	100%	2	0.03%	8205	100%	93	1.14%
2007	9005	100%	539	5.99%	5977	100%	2	0.04%	9174	100%	124	1.36%
2008	8829	100%	430	4.87%	7182	100%	4	0.05%	10307	100%	161	1.56%
2009	8716	100%	661	7.59%	6525	100%	6	0.08%	10417	100%	173	1.66%
2010	9175	100%	310	3.38%	6545	100%	7	0.10%	11434	100%	217	1.90%
2011	9375	100%	251	2.68%	7752	100%	8	0.10%	12211	100%	221	1.81%
2012	9615	100%	186	1.94%	7594	100%	10	0.13%	12417	100%	271	2.18%
2013	9856	100%	195	1.98%	7129	100%	12	0.17%	12105	100%	312	2.58%

Source: OECD. 2014.

Annex 5: Comparison of CO2 emissions per capita produced by meat industry with total CO2 emissions in metric tonnes

Years	Total meat CO2 emissions	Argentina's population	CO2 emission per capita (metric tonnes) produced by meat industry	Total CO2 emissions per capita (metric tonnes)
1995	34 938 000	34 833 168	1.0	3.5
1996	34 137 000	35 264 070	1.0	3.7
1997	34 333 000	35 690 778	1.0	3.8
1998	31 887 000	36 109 342	0.9	3.8
1999	35 123 000	36 514 558	1.0	4.0
2000	35 179 000	36 903 067	1.0	3.8
2001	32 555 000	37 273 361	0.9	3.6
2002	31 700 000	37 627 545	0.8	3.3
2003	33 290 000	37 970 411	0.9	3.5
2004	38 067 000	38 308 779	1.0	4.1
2005	40 048 000	38 647 854	1.0	4.2
2006	39 943 000	39 988 923	1.0	4.5
2007	42 306 000	39 331 357	1.1	4.6
2008	41 970 000	39 676 083	1.1	4.8
2009	45 125 000	40 023 641	1.1	4.5
2010	37 311 000	40 374 224	0.9	4.5

Source World Bank. 2014.

**Annex 6: Share of grain production area on the total arable land
in years 2000 - 2012**

Years	Agricultural land (km²)	Grain production area (km²)	Share of grain production land
1995	1 280 450	52 936	4.1 %
1996	1 281 420	51 723	4.0 %
1997	1 282 350	52 020	4.1 %
1998	1 283 300	48 314	3.8 %
1999	1 284 120	53 217	4.1 %
2000	1 285 100	53 302	4.1 %
2001	1 286 060	49 326	3.8 %
2002	1 287 100	48 030	3.7 %
2003	1 308 835	50 439	3.9 %
2004	1 343 450	57 677	4.3 %
2005	1 377 975	60 679	4.4 %
2006	1 411 040	60 520	4.3 %
2007	1 440 330	64 100	4.5 %
2008	1 440 580	63 591	4.4 %
2009	1 432 970	68 371	4.8 %
2010	1 467 170	56 532	3.9 %
2011	1 475 480	55 630	3.8 %
2012	1 487 910	57 962	3.9 %

Sources: World Bank. 2014. Asia-Pacific Economic Cooperation (Apec). 2012.