Development Of A Methodology To Estimate Ghgs Produced By The Beef Chain In Argentina

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Abstract

The world is nowadays facing a great challenge: the production of food in harmony with the environment. Air pollution resulting from livestock activities and the existing possible solutions are shown as elements of vital importance. This fact definitely leads us to consider this issue from the global, national and local point of view. Each country faces different situations in terms of emissions which result directly from the production activities circumstances. Livestock in Argentina represents a substantial portion of the agricultural activities. Therefore, emissions produced become critical to any climate change mitigation and adaptation policy.

Currently, satellite data can be obtained from an atmosphere scanning with territorial and temporal segregation. This information makes possible to achieve a global worldwide coverage, however, of low accuracy. Although it is not possible to identify sources and specific sumps, data on large areas can be achieved.

Within this context, this project[5] has been framed mainly focused on the creation of estimates of greenhouse gas emissions (GHG) produced by the beef value chain in Argentine on different production scenarios.

This Study has been carried out and promoted by the Ministry of Agriculture, Livestock and Fisheries, managed and coordinated by the

[5] Emisión de gases de efecto invernadero en la cadena de valor de la carne bovina [Greenhouse Gas Emissions of the Beef Value Chain] AACREA [Argentine Association of Regional Consortiums for Agricultural Experimentation]. August 2014. Final Report in the frame of the Specific Agreement set by the Ministry of Agriculture, Livestock and Fisheries and UNTREF [University of Tres de Febrero]. Coordinator: Eng. Cristian Feldkamp, File No. 1608/12.

National University of Tres de Febrero -UNTREF- and developed under the technical advice of AACREA [Argentine Association of Regional Consortiums for Agricultural Experimentation]. The purpose of this paper is to discuss the development of a model in order to estimate emissions of greenhouse gases in the Argentine beef chain on different scenarios for the 2013-2014 period and to propose, on said basis, production models and functional marketing in line with the environmental objectives.

Keywords: Greenhouse gas emissions, livestock, estimates model, pollution, new scenarios

Introduction

The international meat market in general and the beef market in particular have experienced very significant changes over the last decade. World beef trade grew by forty percent (40%), accounting for eight million tons (8,000,000 t) in 2008, and probably approaching ten million tons (10,000,000 t) in the coming years (FAO.OECD). This growth in the traded volume is the result of significant structural changes at the production and consumption level in several countries, including some of the biggest players in the world trade.

Nowadays, the sustainability of the production processes is a growing market demand and therefore, it will represent a sales condition, both at a domestic and international level. Sustainability can not be considered only as a requirement to certify emissions of greenhouse gases (GHGs), but as a tool whose implementation would achieve high standards of environmentally friendly production, under rational social conditions and which would ensure a high level of health protection for consumers of such food and/or beverages.

The Argentine Ministry of Agriculture, Livestock and Fisheries launched the so-called "Intelligent Agriculture Program" that seeks to promote sustainable practices and processes in agrifood chains. The resolution to create this program promotes the implementation of projects for Intelligent Agriculture and encourages improved efficiency of different production systems through an adaptive and sustainable management. Within this framework, the estimation of GHG produced from the beef chain is a project that directly contributes to the achievement of these aspects.

This kind of initiatives seeks to produce an impact on the food industry and on the public-private synergies in order to accomplish competitiveness of exportable agri-products.

Regional specificity of emission calculations is achieved through an accurate description of the production systems, which makes possible to know the proportions of the different categories of animals, quantity and quality of the food they eat, using a suitable Ym factor for said intakes.

In terms of livestock and for information purposes, it results better to compare emissions per kilo of meat produced, than per surface unit as it is usual in Agriculture, due to the diversity of livestock layouts which varies from extensive production on grassland to intensive fattening systems with feed lots.

It results essential to understand the need of taking actions in this context, since it is expected that in the near future the EU will require that all food products entering the EU countries report the environmental footprint, including among other indicators the carbon footprint. These new guidelines mean that major countries should compete with similar or different standards in different parameters, so as to determine how to measure the footprint, trying to show each standard as the most suitable one.

Method to estimate emissions:

Emissions calculation proposed by AACREA[6] is divided into three models: primary production, cattle and industry transportation. Emissions include the estimation of the main sources of emissions, until the release of meat from the meat processing facilities, and exclude transportations to the retailer center or consumer.

Production model:

The selected model to calculate production emissions was the one proposed by the Intergovernmental Panel on Climate Change - IPCC (2006) in its Level 2 analysis. This model includes estimated emissions of methane and nitrous oxide.

Methane is originated from rumen fermentation and manure, either deposited in pastures or managed by wastewater treatment systems. Nitrous oxide is emitted directly from pasture, through volatilization, leaching and runoff of manure, either managed or otherwise. When nitrogen fertilizers are used, nitrous oxide is directly emitted through volatilization, leaching and runoff.

In food production, pasture, grassland or grains, emissions of carbon dioxide, methane and nitrous oxide were estimated by the consumption of fuel used by the machinery, fertilization, and crop residues.

In addition to emissions, the model estimates production of calves (for breeding sub model) and animals to slaughter (breeding and wintering sub models). In this sense, breeding and wintering systems are divided.

[6] AACREA Asociación Argentina de Consorcios Regionales de Experimentación Agrícola [Argentine Association of Regional Consortiums for Agricultural Experimentation].

Furthermore, production systems by area and production level were classified. All calves for fattening which leave farming systems in different areas enter a wintering system in the same or in another area. In each modal production system a stock model is run, annual step of integration where efficiency parameters are exogenous variables.

Local emission factors during production

In discussions on the development of methods to improve the estimation of GHG emissions caused by animal production systems, the importance of local emission factors is frequently mentioned. In case these local factors are not available, those factors proposed for other countries or globally by the IPCC must be used.

Different researches made in our country seek to contribute to the development of said factors[7]

In order to understand the importance of setting local emission factors, it results necessary to explain the impact of these values on the emission calculation models at a country level.

In the case of methane, main GHG from the ruminant systems, the emission of a given animal is calculated by the following equation:

$$E_{CH4} = DMI \; X \; GE \; X \; Ym$$

Where:

E_{CH4} = Energy lost as methane

DMI= Animal's dry matter intake

GE= Gross energy content in food

Ym= Fraction of gross energy lost as methane.

In general, gross energy remains fairly constant among forages. However, it changes in case high lipid content supplements are used.

Dry matter intake is determined by several aspects of the animal, food and by the environment. In terms of the animal, its live weight, body condition, age, physiological status, race and its health condition may influence the food intake. In terms of food, its availability, digestibility and its nutritional balance are aspects that influence consumption. Finally, the environment influences consumption in terms of temperature and presence of mud.

There are several models that make up these factors in order to estimate the dry matter intake[8], which are mechanistic enough to be considered as extrapolated to our country. The challenge to provide locality

[7] See as an example Berra et. al., 2010, Jaurena et al., 2014, Faverin et al., 2013, and Rubio et al., 2011.

[8] For example NRC, 1996.

to dry matter intake is found in an appropriate description of the data used by these estimation models.

In this paper, AACREA has focused on making a suitable description of the production systems, categories and characteristics of animals and forage offered, including concentrations of gross energy.

Ym factor mainly depends on the characteristics of the diet and the use of additives. In general, the more digestible food is, the lower the Ym value will be. Therefore, the energy losses by methane will also be lower.

There is a wide range of Ym values present in the literature that emphasizes the importance of using the most suitable one[9]. The IPCC (2006) for Level 2 analysis proposes two values: 6.5%, when the concentrate content in the diet is less than 90%, and 3.0% when the concentrate content in the diet is equal to or greater than 90%. These values are the result of agreements in the IPCC; therefore they do not necessarily represent the existing conditions in our country. Jaurena et al. (2013) carried out a meta-analysis study of the existing international literature and produced predictive models for situations of Argentina.

Modeling of cattle transport

The link between breeding and wintering systems and among all the production and slaughter systems is stated by cattle transportation. In this connection historic movements have been analyzed and the number of necessary trucks, as well as distances covered, has been defined for all cattle transports. No changes in the transport system structure have been considered within the proposed scenarios.

Modeling of the industry

All animals for slaughter, coming from breeding or wintering systems are annually admitted into the industry model. This model has been adapted from a developed model in order to establish costs for the meat processing industry. In the proposed scenarios, no changes were considered in the structure of the meat processing industry.

Description of the primary sector

The primary production sector of the bovine meat chain can be characterized by two production stages: breeding and wintering, including rearing and fattening in the latter. At a domestic level, cattle breeding, which accounts for approximately 21 million bellies, shows a calf production of 63%, whereas about 15 to 20% of heifers are intended for herd's replacement. About 3 to 5% of calves are considered as breeding males. The

[9] Jaurena et al., 2014.

remaining calves and heifers enter the wintering stage, either directly to the fattening stage, or through a previous rearing stage.[10]

In order to portray the primary production sector, the representation of production systems by means of Mode Systems (MS) has been proposed. The Mode Systems are production layouts that have common production resources, the produced product, and similar manners to respond to environment changes.

Each Mode System does not represent a particular cattle farming, but an activity (in the business sense), which may be part of a business with several activities, or the whole business itself when it has that single activity.

The regionalization of the country in five areas, as proposed by the INTA (2007) has been adopted as follows: Northeast, Northwest, South, Pampas and Patagonia areas. Given the heterogeneity and relevance in terms of number of heads, the Pampas area has been subdivided into North, West, Southeast and Southwest subareas.

- **Breeding activity: Characterization per production level:**

Breeding systems are classified into three production levels: high, medium and low level within each area. This meets the need to distinguish the different forms of production, understood as the interaction among environmental potentials, use of technology and production scale.

- **Wintering activity: multi-criteria characterization:**

Multiple grouping criteria were used for wintering activities, including the duration of the wintering period, the weight of animals at admission and discharge, and the resources used in the cycle. In this sense, a system range was created, varying from the most intensive, shortest systems and with high proportion of concentrates in diets, to the most extensive ones including high proportions of pasture resources in feeding.

Productive scenarios

Building scenarios involves not anticipating the future, but thinking of ideas internally consistent with it[11]. Although it is not a forecast, it makes it possible to assess the potential impact that the execution of these future assumptions may have on the system under study. Taking into account one aspect of the chain, three possible scenarios were raised: a trend scenario, a pessimistic scenario and an optimistic one.

Each scenario basically responds to decisions made in the primary production sector, in response to expectations and general conditions of the scenario in question. In general, history shows cycles of 4 to 6 years where business expectations change from very unfavorable to very good ones.

[10] Pursuant to SIIA’s figures for 2014.
[11] Porter, 2002.

Therefore, looking backwards, a realistic scenario should include an expectations sequence.

However, there are two main reasons not to follow that path. Firstly, defining a possible sequence of expectations involves countless uncertainties which may hinder the identification and understanding on the part of the reader, of the raised scenario. On the other hand and most important, the goal is the raising of the scenarios, it is not the forecast, but the identification of trends of what might happen if different situations arise.

- ✓ The trend scenario: This scenario, taken as baseline, assumes that the macroeconomic environment will be neutral in the coming years. As such, and considering the trend for the 2013/14 period, it is assumed that the livestock producer has relatively low expectations on the cattle business, with export values similar to current ones. This situation results in maintaining the stock of bellies, the relation calf-cow and the average slaughter weight. The duration of the wintering stage is supposed to be kept, thus the extraction rate of males will result stable.
- ✓ The pessimistic scenario: This scenario assumes a negative macroeconomic environment that generates and holds low expectations on the livestock business. This results in a reduction of females' stock, a slight fall in the relation calf-cow, as well as in the average slaughter weight, and in the male extraction rates, showing fatting systems mainly short and with minimum herds. This scenario is supposed to have a higher reduction in exports, resulting in values lower than those of 2013.
- ✓ The optimistic scenario: This scenario assumes a positive macroeconomic environment, promoting high expectations on the cattle business. This situation leads to a reduction in the percentage of females to slaughter, an increase on females' stock and an increased calf-cow relation. Within this scenario, exports are agile and show increasing values. This scenario generates an increase in the participation of herds that slightly extend the fattening period of males (the extraction rate of males falls), as well as a progressive increase on the average slaughter weight.
- ✓ Compared scenarios: conducting variables and productive results. The optimistic scenario assumes an increase in the number of bellies through a greater replacement of heifers and calves, and a reduction in the slaughter of adult females (longer lifetime of bellies). In turn, in the pessimistic scenario, the slaughter of females increases due to fewer calves and heifers selected as replacement, and to an increased slaughter of adult females (shorter lifetime of bellies)

PEAA [Agri-Food and Agribusiness Strategic Plan] **and the optimistic scenario:**

The optimistic scenario shows some variables with values close to the goals set by the Agri-Food and Agribusiness Strategic Plan (PEAA, for its acronym in Spanish). For example, by 2020 the PEAA proposes a cattle stock which totaled 54.5 million head (55 million in the optimistic scenario), 68% of weaning (68% in the optimistic scenario), a slaughter of 3.5 million of t eqRcH[12] [tons equivalent to in-bone beef] (3.4 in the optimistic scenario), and a consumption per capita ranging between 54 and 60 kg (61 kg in the optimist scenario). The PEAA assumes an export of 1,000,000 tons equivalent to in-bone beef, while the optimistic scenario assumes 680,000 tons equivalent to in-bone beef in 2020. The difference may be in part due to different average slaughter weights (higher in the PEAA) and to the population (less in the PEAA).

Results of emissions

The estimation of emissions generated by the chain has been made for the three productive scenarios outlined for the primary production sector, cattle transport and industrialization. Results are shown firstly by sector and afterwards comprehensively.

Emissions from production

The emissions generated from the production have been calculated using the 2006 IPCC Ym factor (YmIPCC) and the Ym factor proposed by Jaurena et al. (2013, Ym-Mod). These factors have been applied to both, breeding and wintering systems; thus, the analysis is carried out per production stage.

Emissions from the wintering stage

As in farming, enteric fermentation is the main source of emissions regardless the Ym factor used and the scenario raised. Pasture and food management increase to the extent of their participation, because the wintering layouts contain a greater portion of supplements and implanted pastures, compared to farming systems that mainly rely on natural or long-lasting grasslands.

Emissions from farming and wintering

The main source of emissions from production is the enteric fermentation: 72% of emissions irrespective of the scenario. The second one

[12] t eqRcH means tons equivalent to in-bone beef.

is the manure management (26%) and finally food production and management (3%).

For the average of 10 years, the difference among the scenarios in terms of total production emissions with respect to the trend scenario is 4.3% lower emissions in the pessimistic scenario and 10.0% more emissions in the optimistic scenario. If the last four years (2020-2023) are considered, in terms of cattle transport, the pessimistic scenario generates 6.0% lower emissions and the optimistic scenario 13.6% more emissions than the trend scenario.

Emissions from transport of cattle

Emissions derived from transport of cattle are generated by the fuel used in transportation. There exist three kinds of movement: animals from breeding systems to slaughter, animals from breeding systems to wintering and animals from wintering systems to slaughter. The necessary transport is related to the amount of animals produced and slaughtered; that is why the pessimistic scenario initially shows greater emissions, which later decline. Conversely, the optimistic scenario shows lower emissions first, in the period of retention and growth of bellies stock, and an increase afterwards according to the rise in production and slaughter.

The movements from the wintering systems to slaughter show the highest emissions of the three scenarios: 48% (trend and pessimistic scenarios) to 49% (optimistic scenario). In general, these movements are shorter than those from breeding systems to wintering; however, each truck carries fewer animals. Emissions from wintering to breeding systems represent a 46% (trend and pessimistic) to 45% (optimistic). Finally, emissions produced by animals transport from farming systems to slaughter account for 5% (pessimistic and trend scenarios) to 7% (optimistic scenario) emissions from transport. Considering the 10 years assessed the difference among scenarios in terms of total emissions from cattle transport with regards to the trend scenario results in 4.4% lower emissions in the pessimistic scenario and 4.5% more emissions in the optimistic scenario. If the last four years (2020-2023) are considered in terms of cattle transport, the pessimistic scenario generates 9.3% lower emissions and the optimistic one 9.8% more emissions than the trend scenario.

Emissions from the meat-processing industry

The meat processing industry generates GHG emissions produced by energy consumption (electricity and gas) and the effluents generated.

The main source of the industry emissions are effluents: 61% for the average of 10 years of industry emissions in all scenarios. Natural gas is the second source of emissions (26%), and finally electric power (13%). In the

10 years considered, emissions produced by the industry in the pessimistic scenario are 4.2% lower and in the optimistic 10.1% higher than those produced in the trend scenario. If the last four years are considered (2020-2023) the industry generates 7.4% lower emissions in the pessimistic scenario and 15.9% more emissions in the optimistic than in the trend scenario.

Total emissions

Production is the stage that produces the largest proportion of GHGs in any scenario: an average of 98.3% in the 10 years considered. In second place, the meat processing industry (ranging between 1.5% and 1.6% depending on the scenario) and the transport (0.1% and 0.2%) are located.

Conclusion and recommendations

The scenarios depicted show great potential to increase livestock production and, consequently, exports to the world market. It is remarkable that with current fattening systems in new and reasonable proportions, it is not possible to significantly increase the average slaughter weight. In this sense, it results necessary to change the production systems; therefore, a change in business expectations for the medium and long term results essential.

The model used includes the main sources of greenhouse gas emissions from livestock, transport and industry. The use of the Ym-Mode involves reporting higher emissions than the default values proposed by the IPCC. Chain’s greenhouse gas emissions are mainly generated in the primary production sector. The main source of emissions in the meat chain is produced by enteric fermentation. This process represents an ecological and economic advantage due to its production capacity from food with no other use. However, it generates a significant amount of greenhouse gases. Since this model has a higher proportion of adult animals that eat regular quality food, it is in the breeding stage where GHGs are mostly emitted. Emissions per head can be hardly reduced in a significant proportion.

The model shows that when production and efficiency increase at the chain level, the intensity of emissions per product unit is reduced. The strategy to be followed should therefore be focused on reducing the intensity of emissions. Changing the focus of the discussion of total emissions to the intensity of emissions, makes it possible to settle goals in order to increase production and reduce environmental impact.

Therefore, creating medium and long-term policies that promote the development of livestock is also desirable from an environmental point of view considering greenhouse gas emissions. Policies that help to create a favorable cattle business context in the medium and long-term, lead to productive, economic and environmental benefits in terms of reducing the intensity of emissions.

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