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LOW-EMISSIONS DEVELOPMENT OF THE BEEF CATTLE SECTOR IN ARGENTINA

Reducing enteric methane for
food security and livelihoods



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Executive summary

This study evaluates the potential for improving beef productivity while reducing enteric methane emission intensity from beef production in Argentina. The overall objective of this study is to support Argentina in identifying low-cost strategies to reduce enteric CH₄ emissions while contributing to the countries' short- and long-term social and economic development and increasing resilience to climate change.

Benefits of moving to a sustainable and low-carbon beef sector

Like many other economies in transition, Argentina faces the dual challenge of promoting development and reducing GHG emissions. The Argentinean government is increasingly formulating policies that are aimed at improving productivity, improving the competitiveness and addressing environmental sustainability of the sector. Argentina has in its 2020 strategic plan set targets for growth in of the beef cattle sector; by 2020 the government plans to increase beef production by 46%.

Transitioning its beef sector towards a sustainable and low-emissions pathway could benefit Argentina in several ways:

- Cattle production remains one of the most important economic sectors and important source of export earnings in Argentina. The beef sector is an outstanding component of the economy, generating 22% of the agricultural sector gross domestic production and 6% of the total manufacturing production¹. Beef production is important sub-sector with about 200,000 beef producers managing about 52 million head of cattle.
- With an economy highly dependent on agriculture, Argentina is likely to suffer disproportionately from the impacts of climate change. Argentina is well-known for its pasture-fed beef with

beef producers operating within a high degree of climatic variability, driven largely by periods of severe drought or flood therefore Argentina has a strong interest in addressing climate change. Livestock producers in Argentina are already experiencing climate change and variability, and threats to production are expected to multiply in the short and medium term. In recent years, extreme climatic and eco-systemic events have been observed more frequently and intensely in Argentina. Not only do adverse climatic events have a significant impact on the sector and erode natural capital with long-term effects, but they also produce revenue losses. In 2008/09, severe drought in the central north Argentinean provinces caused the death of 700,000 livestock, hampering meat and milk production. It also resulted in a 70% decrease in beef exports and a 15% decrease in consumption. Likewise, the “El Niño” event of 2016 is reported to have lowered milk production by 25 percent².

- Numerous “no-regret” interventions (interventions that have positive economic returns and can be undertaken irrespective of climate change considerations) can contribute substantially to farm incomes and economic development, an incentive for beef producers to adopt productivity-enhancing technologies.
- Considering the importance of the beef sector enterprise to rural livelihoods and its potential role in poverty reduction, implementing a low-carbon development strategy for the beef sector through the adoption of performance-enhancing technologies is expected to significantly increase yields with net benefits in the short and medium term exceeding the costs associated with their adoption. There is evidence of a large productivity gap

¹ Instituto Nacional de Estadísticas y Censos (INDEC) (2012) Agregados macroeconómicos

² USDA-GAIN, 2016. http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Dairy%20and%20Products%20Semi-annual_Buenos%20Aires_Argentina_5-11-2016.pdf

both within and between systems. For example, in cow-calf systems distinct differences in productivity between the three agro-ecological zones were found. Productivity (kg live-weight produced/hectare) was found to be highest in the temperate zones; with an average of 113 kg live-weight /ha and a wide range around this average (from 26 kg live-weight /ha to 253 kg live-weight/ha). On the other hand, productivity levels in sub-tropical and arid/semi-arid zones were found to be within a similar range, an average of 21.9 and 22.3 for sub-tropical and arid/semi-arid zones, respectively and a wide-range around the average (10 kg LW/ha -115 kg live-weight/ha).

- By pursuing low emissions development of its beef sector Argentina is more likely to benefit from strategic and competitive advantages, such as the transfer of financial resources through the carbon market, new international financing instruments, and increased access to existing and emerging global markets for their low carbon products. Argentina is already actively participating in the international market of beef and currently has access to Europe's high quality beef quota; the "Hilton Quota" and the "481 beef quota" for the European Union. In the past, its position in the global market has been enhanced by a number of factors such as its sanitary and disease status and traceability system. In the future, lowering the emission intensity of beef may create additional competitive advantage for the Argentinean beef sector.

Emissions and emission intensity from beef production systems in Argentina

Beef cattle production in Argentina can be categorized under two broad production systems: (i) breeding systems, commonly referred to as cow-calf; (ii) rearing and fattening³. The beef production cycle in Argentina can be divided into breeding and rearing/growing and finishing activities. Farms can specialize in breeding of calves, finishing (fattening) or both.

This study found that in 2014, the beef cattle sector in Argentina emitted 169 million tonnes carbon dioxide equivalent (CO₂ eq.). Within this, enteric methane represents about 62% of the total

GHG emissions from beef production, equivalent to 104.8 million tonnes CO₂ eq. Emissions associated with the deposition of manure on pasture contributes an additional 58.2 million tonnes CO₂ eq., 34.5% of the total GHG emissions from the beef sector.

The cow-calf system is responsible for 85% of the total GHG emissions associated with the production of beef. The bulk of the emissions (52%) are from cattle raised in the temperate zone; beef production from cow-calf systems in the sub-tropical and arid/semi-arid zones contributes 29% and 19%, respectively. Rearing and finishing and fattening in feedlots contribute 13% and 2% of the total GHG emissions, respectively.

Emission intensity of beef in Argentina is on average 23 Kg CO₂ eq./kg LW produced. At system level, emission intensity was 36.1, 7.8 and 7.1 kg CO₂ eq./ kg LW for cow-calf, rearing and fattening and feedlot systems, respectively.

Emission intensity was also found to vary across agro-ecological zones within the same system: 30 kg CO₂ eq./kg LW, 39 kg CO₂ eq./kg LW and 52 kg CO₂ eq./kg LW for cow-calf systems in the temperate, arid/semi-arid and sub-tropical zones, respectively. Average GHG emissions per kg of LW in the rearing and fattening phase were: 7.2 kg CO₂ eq./kg LW, 9.6 kg CO₂ eq./kg LW and 7.1 kg CO₂ eq./ kg LW in the temperate, arid/semi-arid and sub-tropical zones, respectively.

Options for improving productivity and enteric methane mitigation, by system

Improving animal productivity is one of the key pathways to reduce enteric CH₄ emissions per unit of product. As part of the improvement in production efficiency, a greater portion of the energy in the animal feed is directed towards the creation of useful products so that methane emissions per unit product are reduced. Reducing enteric CH₄ via increasing productivity can have a monetary value; several activities that reduce methane emissions have low or negative economic cost when the value of the gains in output (in product) is considered.

Research in Argentina and elsewhere has already identified several technologies that if comprehensively applied throughout the sector would make a rapid

³ See section 3 for a detailed description of beef production systems.

and emission intensity. Improved practices and technologies such as better pasture management, strategic supplementary feeding, and substitution of high fiber forages, adequate animal health control, and genetic improvement of animals are some of the techniques that can improve livestock productivity and reduce emission intensity.

This assessment evaluated interventions for two main beef production systems: *cow-calf, rearing and fattening beef productions systems*. The following criteria were used to select interventions:

- Interventions had to have potential for improving productivity while at the same time reducing enteric CH₄ emissions per unit of output.
- Interventions had to be feasible in the short or medium term. Feasibility was first determined by sectoral experts and selected interventions had to have already been implemented or in use at least at farm level in Argentina.

A team of national experts identified key areas to address low-productivity in beef systems including (i) improving the quality and productivity of native pastures and rangelands (ii) improved pasture management; (iii) strategic feeding and supplementation to address the feed seasonality constraints; and (iv) improved herd management and animal health interventions. Within this broad categorization, 8 single interventions and 6 'packages' of interventions were assessed in this study.

Significant gains can be realized: between 19% - 60% reduction in emission intensity and an 24%-70% increase in beef production

Implementing the individual interventions would reduce enteric CH₄ intensity by between 3% and 39% (kg CH₄/kg live weight), depending on the intervention and production system. These emissions reduction potentials can be considered conservative, in that the analysis did not assume any major changes in technology or change in production systems but focused on reducing the efficiency gap between producers in the same production system. All interventions returned a positive productivity outcome with increases in beef production ranging between 2% - 65%.

Additional significant reductions in emissions can be achieved through the combination of herd and health management, and nutrition and feeding management strategies. This study estimates a reduction potential between 19% - 60% in emission intensity and an increase in production (expressed in live-weight terms) of 24% - 70% compared to the baseline situation.

Prioritization of interventions for enteric methane

From the analysis, it is clear that the assessed technologies not only yield mitigation benefits but also provide production benefits and high returns to farmers. A preliminary ranking of interventions per production systems to identify those with high reduction potential, increased production and high emissions economic return was undertaken to provide an indication of what is workable.

Out of the 8 interventions preselected and assessed for their potential to reduce enteric methane emissions, only 4 (use of deferred fodder, control of reproductive diseases, controlled mating, and supplementation of steers) were included in the prioritization process. The others were excluded from the prioritization because of their low impact on enteric CH₄ emissions (<10%). Two interventions (use of deferred forage and control of reproductive diseases) were the were found to have the highest potential to balance all three criteria of reducing methane, increasing productivity and increasing profitability.

Harnessing development for the beef sector

Several interventions in the beef sector have the potential to mitigate GHG emissions. These technologies have either already been developed or are being adopted by farmers, indicating that there is no lack of productivity-enhancing technologies. The fact that many of these interventions have not already been adopted on large-scale suggests that there are barriers to implementation. To establish support for greater implementation there is a need to begin with measures that have positive economic returns for farmers while having positive social and environmental co-benefits.

The adoption of low-carbon growth development strategies will put enormous demands on the country's resources, capacities and skills. It will require aligning investment and spending decisions with financing sources, and short-term growth promotion with long-term strategic decisions regarding sector development and technology choices. Such choices, in turn, will need to be aligned with broader development policies, including those aimed at stimulating job creation, strengthening productivity growth, and

ensuring food security. Policy makers will have to carefully weigh the adaptability of the technological options available to them for scaling-up. Since, technologies are highly location specific, technology targeting in terms of ecological and socio-economic conditions of farmers is important in order to achieve maximum mitigation potential. To do this, there is a need for local experimentation to gain experience on the ground and to better understand the role of policy and new investment mechanisms.

CHAPTER 1

A national commitment to low development of the beef cattle sector

Like many countries, Argentina has with its Nationally Determined Commitment (NDC) made a clear commitment to adopt a low-carbon growth agenda, thus contributing to the global agenda on climate change. In its NDC, Argentina commits not to exceed net emissions of 483 million tonnes CO₂ eq. in the year 2030⁴. It intends to achieve this goal through a series of measures focusing on the agriculture, forestry, energy, transport and industry sectors.

Argentina has identified national goals for the agri-food and agro-industrial Sector⁵ to be achieved by year 2020. The plan sets targets for growth in the livestock sector; by 2020 the government plans to increase beef production by 46%. This goal of increasing productivity cannot be met without addressing the drivers of low productivity and the challenge of climate change. The agriculture sector (including livestock, forestry and land use) accounts for approximately 46% of total national GHG emissions in Argentina⁶. The livestock sector in Argentina is responsible for 41% of the direct methane and nitrous oxide emissions in agriculture.

Argentina clearly has a comparative advantage in pursuing a low-carbon growth path for its beef sector, by means of implementing policies and programs to improve productivity. To realize this potential requires identifying concrete opportunities for reducing GHG emissions without compromising sustainable development objectives.

The adoption of technologies and practices provides opportunities for sustainable intensification consistent with food security and development goals, climate change adaptation and mitigation needs, thus enhancing development with considerations of environmental, social, and economic issues. At the same time, it is important to recognize that Argentina

is already experiencing significant impacts from climate change and adaptation solutions are needed to reduce its vulnerability. Cattle producers in Argentina are already experiencing climate change and variability, and threats to production are expected to multiply in the short and medium term. In recent years, extreme climatic and eco-systemic events have been observed more frequently and intensely in Argentina. Not only do adverse climatic events have a significant impact on different sectors of the economy and erode natural capital with long-term effects, but they also produce revenue losses. In 2008, severe drought in the central north Argentinean provinces caused the death of 700,000 livestock, hampering meat and milk production. Likewise, the “El Niño” event in 2016 is reported to have lowered milk production by 25 percent.

This report presents the findings and recommendations from an initial assessment of the beef cattle sector of Argentina. It is undertaken as part of a project led by Instituto Nacional de Tecnología Agropecuaria (INTA) and funded by Climate and Clean Air Coalition (CCAC), the New Zealand Government and Food and Agriculture Organization of the United Nations.

The primary focus of this initial assessment is to identify and prioritize interventions to reduce enteric methane emission intensity from ruminant systems that are consistent with other development goals. To that end, this report examines the scale of enteric methane emissions from the beef sector, and identifies cost-effective interventions through which methane can potentially be reduced. This analysis is meant to inform where reductions can be made and to systematically explore emission reduction opportunities with the objective to translate emission savings into benefits for producers.

⁴<http://ambiente.gob.ar/wp-content/uploads/NDC-Revisada-2016.pdf>

⁵http://inta.gob.ar/sites/default/files/inta_000001-libro_pea_argentina_lider_agroalimentario.pdf

⁶CAIT/WRI database, 2012

CHAPTER 2

Objectives and approach

This study seeks to identify and evaluate low-cost options that Argentina can implement in the short-to-medium term geared towards improving productivity in beef production systems, reducing enteric methane emissions and fostering economic development.

Three main methodological steps were employed in this study (Figure 2.1):

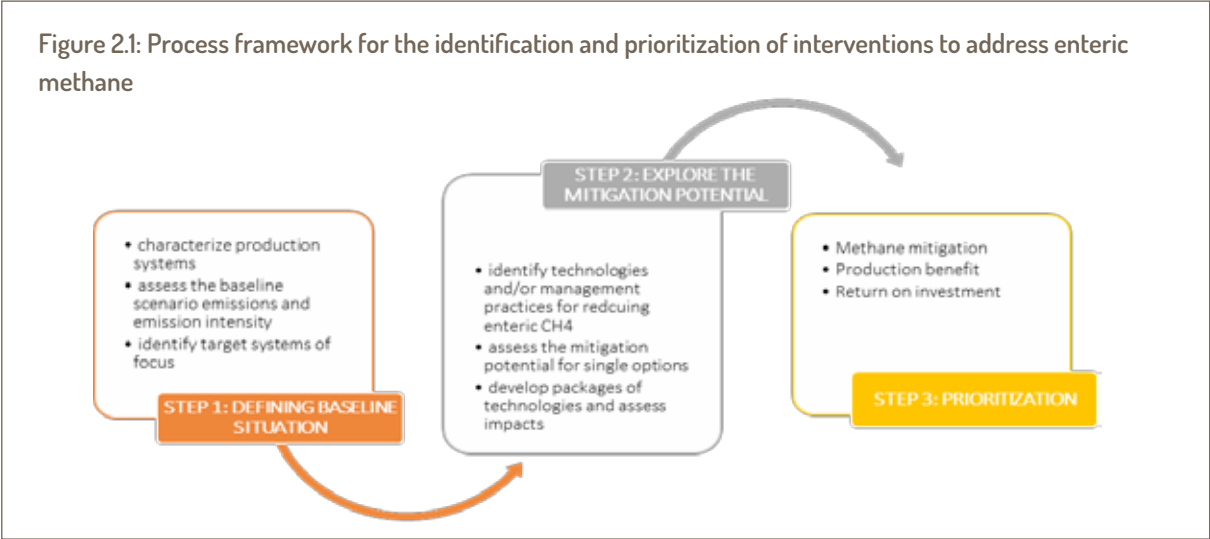
- 1) Establishment of the baseline scenario.** Including the selection and characterization of production system, estimation of GHG emissions and emission intensity, and identification of key determinants of low productivity and emission intensity.
- 2) Assessment of the mitigation potential.** Identification of system specific interventions consistent with development objectives for improving productivity, addressing enteric methane emissions and assessment of the mitigation potential.
- 3) Prioritization of interventions.** Prioritization of interventions is undertaken by drawing on modeling results (of emission intensity reductions and productivity impacts) as well as cost-benefit analysis. It assesses productivity impacts, and the potential profitability for farmers in adopting the selected interventions.

A key focus of this work is on interventions that reduce emission intensity while maintaining or increasing production such that productivity improvements and climate change goals can be pursued simultaneously (Box 1).

The analysis focuses on the beef cattle sector, a strategic sector of importance to Argentina that was jointly identified in consultation with front-line government ministries e.g. Ministry of Agro-Industries and related national agencies such as INTA, research academia institutions, and public and private stakeholders.

The study undertakes biophysical modeling and scenario analysis using the Global Livestock Environmental Assessment Model (GLEAM) to provide a broad perspective of opportunities and the potential achievable goals in terms of productivity gains and emission intensity reduction in the beef sector (Box 2).

The scenario analysis uses the outputs of the biophysical analysis combined with information taken from published literature, existing studies and expert knowledge on potential impacts of each intervention on herd performance indexes and production to quantify the emission intensity reduction potential.



Box 1: Absolute emissions versus emission intensity

The primary drivers of enteric methane emissions are feed intake, and fermentation of that feed in the rumen. In general, management practices that increase the proportion of feed used to produce meat or milk rather than maintain the animal, reduce the amount of methane per unit of animal product produced (emissions intensity). Higher individual animal productivity generates the same amount of animal product with fewer methane emissions if producers keep fewer animals. More intensive production provides flexibility to control emissions and

generally improves profitability. However, increasing feed intake per animal will always lead to an increase in total farm methane production unless the total number of animals is reduced. In low and medium income countries, the concept of emission intensity remains the most attractive mitigation route because it allows for the harnessing of synergies between food security and development objectives and climate change mitigation goal. Emissions intensity reductions will reduce absolute emissions below business-as-usual.

Box 2: Modelling GHG emissions from beef production systems in Argentina

In this study, the Global Livestock Environmental Assessment Model (GLEAM; Gerber et al. 2013) is the main analytical tool used to assess the emissions and emission intensities in the baseline scenario and to assess the emission reduction potentials of selected interventions.

GLEAM is a spatially model of livestock production systems that represents the biophysical relationships between livestock populations, production, and feed inputs (including the relative contribution of feed types—forages, crop residues, and concentrates—to animal diets) for each livestock species, country, and production system. The production parameters and data in GLEAM have been drawn from an exhaustive review of the literature and validated through consultation with experts during several joint projects and workshops. The relationships between GHG emissions and production have also been cross validated for ruminants across a range of regions and studies, and published reports on GLEAM have also been through rigorous peer review (Opio et al. 2013; Gerber et al. 2013). GLEAM works at a definition level of 1 km², the spatially explicit GLEAM model framework allows the incorporation of heterogeneity in emissions, emission reductions and production responses.

The model was further developed to meet the needs of this study. The beef production systems in GLEAM were further refined to reflect the specificities of the beef systems in Argentina and the database of production sys-

tems parameters was updated with more recent and system specific information and data on animal populations, performance parameters, feeding systems, manure management, etc. taken from national databases.

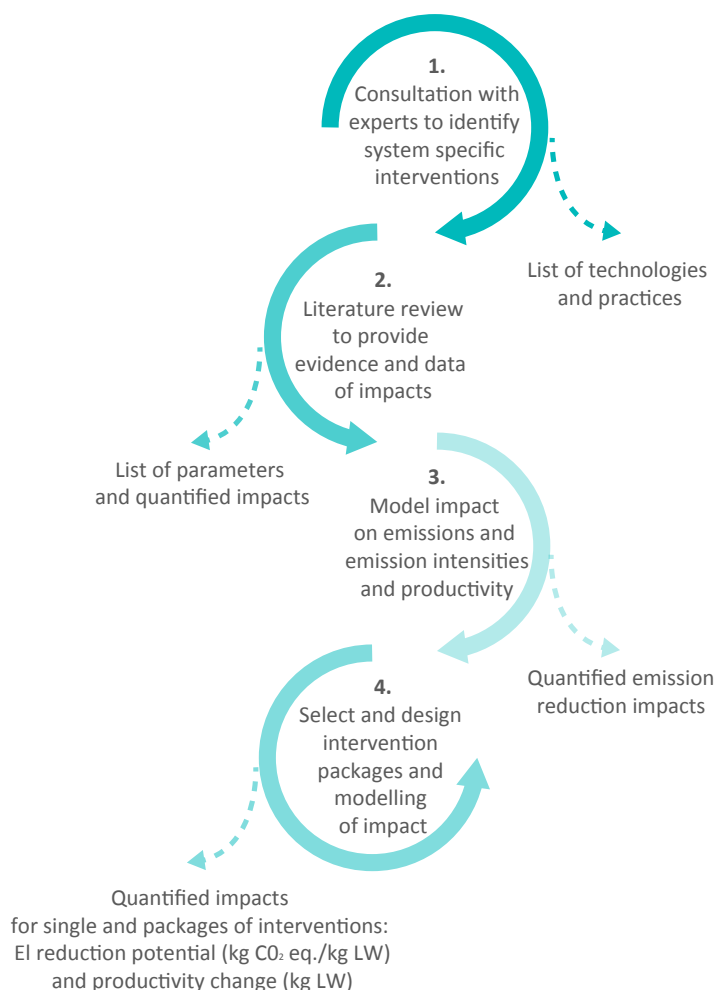
The GLEAM framework is used to characterize the baseline production and GHG emission output of beef production systems. Emissions and emission intensities are reported as CO₂ eq. emissions, based on 100-year global warming potential (GWP100) conversions factors; as reported by the IPCC in its 5th Assessment Report (AR5).

The abatement potentials for each practice were calculated by estimating the changes from the baseline GHG emissions, following the application of each system specific intervention. To specify each abatement practice within GLEAM, it was necessary to incorporate additional data and information on the impacts associated with the application of the interventions. These data were obtained from a range of literature sources, databases and expert knowledge.

The calculations are performed twice, first for the baseline scenario and then for the mitigation scenario. Emission intensity reductions and changes in productivity achieved can then be compared to those under baseline scenario.

Source: GLEAM: <http://www.fao.org/gleam/en/>
Gerber, P. J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. (2013). Tackling climate change through livestock: a global assessment of emissions and mitigation opportunities; Opio, C., Gerber, P., Mottet, A., Falcucci, A., Tempio, G., MacLeod, M., Vellinga, T., Henderson, B. & Steinfeld, H. (2013). Greenhouse gas emissions from ruminant supply chains – A global life cycle assessment, Rome.

Figure 2.2: Process for exploring mitigation impacts



The range of options evaluated (referred to as “interventions”) were selected by national sector experts based on their potential for methane emission intensity reductions, their impact on yield and their feasibility in terms of political, social, institutional, and other preconditions. The interventions identified are presented both individually and as “packages”, in order to allow stakeholders to assess how a combination of reduction activities would impact reduction potential and productivity gains. It also gives the ability to assess this flexibly within the framework of political conditions, available resources, and other considerations. Figure 2.2 presents the steps undertaken in the identification of interventions and assessment of their impacts on enteric methane emissions and production.

For purposes of prioritization of interventions, the assessment considered three aspects: the emission reduction potential, the production impacts and the impacts on profitability for farmers i.e. the return to farmers per dollar invested (see Section 6). The impacts on enteric methane emissions and production were assessed using the GLEAM model described in Box 2. The cost-benefit analysis of selected interventions to assess the profitability for farmers were quantified using typical farm input and output costs provided by local experts and are presented as a ratio of the \$ returned per \$ invested. The purpose of the cost benefit analysis is to guide decisions on which interventions would be profitable for farmers.

CHAPTER 3

Overview of beef production in Argentina

Argentina is well-known for its pasture-fed beef. Traditionally, beef production in the country has been based on low-input systems combined with improved perennial and annual pastures to provide beef year around. Over time, these systems have evolved adjusted to economics, market changes and resource pressures. The beef and cattle industry is an important part of Argentina's agricultural sector; the beef sector generating 22% of the agricultural sector gross domestic production.

With almost 52 million head of cattle, the beef cattle sector in Argentina consists of more than 200,000 farms (SIGSA and SENASA, 2014). The vast majority of farms (88%) have fewer than 500 animals, but these account for only 40% of the cattle inventory. Only 12% of the farms hold 53% of the cattle inventory, with a range of 501 to 5,000 animals.

Beef production is undertaken within an immense diversity of situations across a wide array of economic, production, socio-demographic, geographic, and environmental characteristics-such as their size of operation, production technologies and practices in use, climate conditions, soil composition, and location-specific environmental factors. Cattle production in Argentina takes place in very diverse ecological regions with huge differences in climate, soils, and vegetation. Argentina is divided into three climatic areas: arid/semi-arid, temperate, and subtropical zones^{7 8} (Box 1). These three agro-ecological zones are further subdivided into 5 regions including: the Argentinean North West (NOA), the Argentinean North East (NEA), the Semi-arid, Pampeana, and Patagonia.

Beef production systems

Cattle production occurs in virtually all of Argentina's climatic environments. These diverse environments determine production objectives, breed choices, stocking rates, management practices, and management styles

for the different regions. Figures 3.1-3.3 represent the production systems and phases as well as key production parameters. Traditionally, beef production in the country has been based on low-input systems based on rearing of animals on native pastures combined with improved perennial and annual pastures to provide beef year around. Over time, these systems have evolved and have had to adjust to economics, market changes and resource pressures.

Beef production in Argentina can be divided into two main systems (cow-calf and growing and fattening systems) with three main phases: breeding, rearing and fattening on pasture and rearing and fattening mainly on grain. These activities are carried out across all the agro-ecological zones.

Cow-calf systems: In Argentina, cow-calf activities are generally carried out on native pastures and grasslands with grazing occurring all year round. Fertilization of native grasslands and pastures is not a common practice as a result pastures do not provide adequate nutrition. British breeds (Aberdeen Angus and Hereford) and crossbreed (British breeds with *Bos Indicus*) are the most common breed types. Regarding herd management, farmers generally aim for spring calving with breeding concentrated between 3-4 months. Heifers and cows are bred using bull service and the use of artificial insemination is rare. Sub-nutrition and reproductive diseases such as *trichomoniasis*, *campylobacteriosis*, and *brucellosis* are widespread which explains the longer calving intervals (15-18 months), low calving, weaning rates and low productivity (see Figures 3.1-3.3). As calves are the main output of this system, reproductive efficiency is a key factor determining profitability in cow-calf systems. Pregnancy rates generally range from 80-90% depending on the herd management and forage availability; while weaning rates vary from 50-

⁷ Fernández, O. A., and C. A. Busso. 1999. Arid and semi-arid rangelands: Two thirds of Argentina. Pages 41-60 in Case Studies of Rangeland Desertification. Arnalds, O., and Archer, S., ed. Agricultural Research Institute Report 200, Reykjavik, Iceland.

⁸ D. H. Rearte 2007. La producción de carne en Argentina. II. Programa Nacional de Carnes. Instituto Nacional de Tecnología Agropecuaria, Buenos Aires, Argentina.

Box 3.1: Geo-climatic production regions

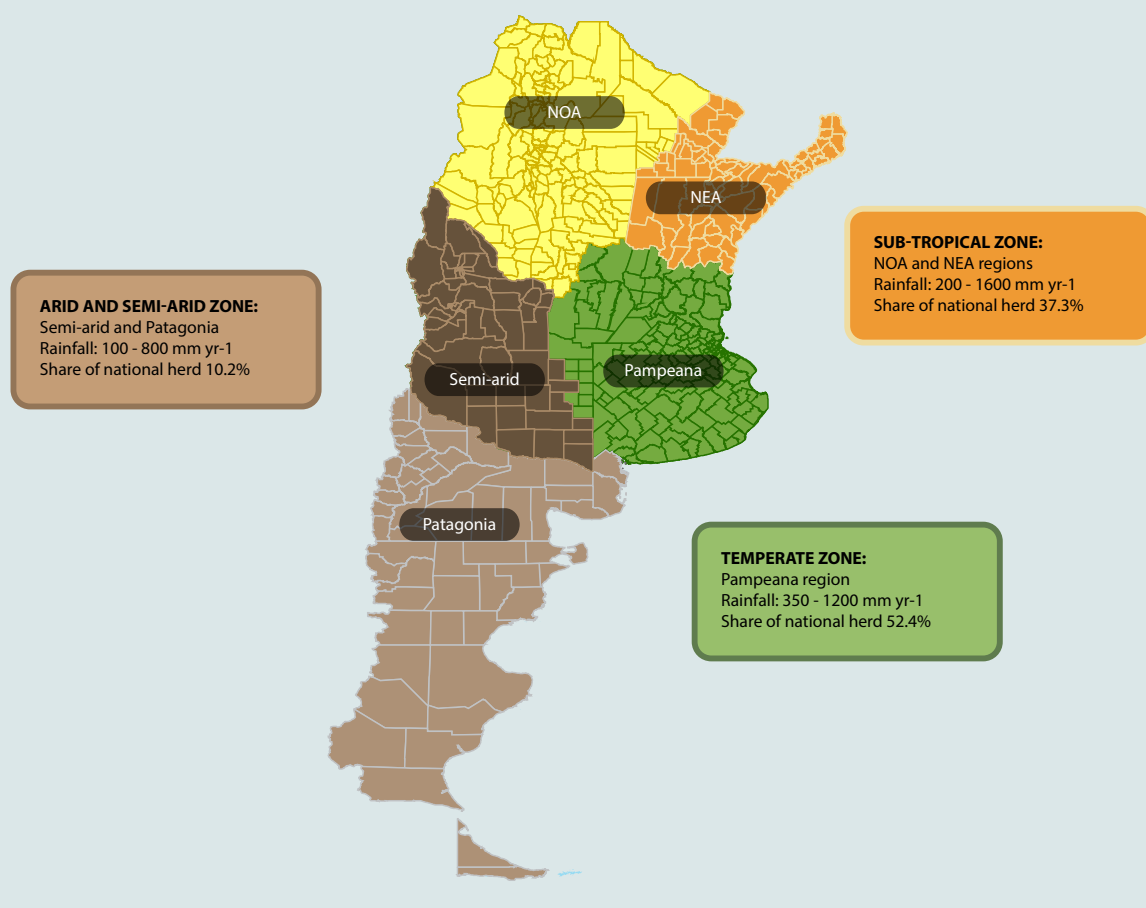
The **temperate zone** refers to the “Pampeana” region, and includes Buenos Aires province, the south central part of Entre Rios province, the south central part of Santa Fe province, the east central and the southern part of Cordoba province and the northeast part of La Pampa province. The region has a temperate weather with rainfall ranging from 1200 mm in the northeast to 350 mm in the southwest. This region manages on average 52.4% of the national herd.

The **sub-tropical zone** includes NEA (North East) and NOA (North West) includes the following provinces: Northern of Entre Ríos and Northern of Santa Fe, Corrientes, Misiones, Chaco and Formosa (NEA); and north-west of Córdoba, Jujuy, Misiones, Salta, Tucumán, Catamarca, La Rioja, and Santiago del Estero (NOA). Climate ranges from subtropical to temperate and rainfall ranges from 1600 mm per year in Misiones (NE) to 200 mm per

year in the west (Catamarca and La Rioja), with intermediate records around the centre of Chaco (approx. 900 mm per year). This region holds 37.3% of the national herd.

The **arid/semi-arid zones** includes Semi-arid and Patagonian regions. It comprises of the following provinces: San Juan, San Luis, Mendoza, Centre and West of La Pampa and the Southern part of Buenos Aires (semi-arid); and Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego (arid). In the northern sub-region, the climate is subtropical with rainfall decreasing from East to West from 500 to 100 mm per year. In the southern sub-region, Patagonia, climate is temperate – cold, with rainfall increasing from East to West from 150 to about 800 mm in the mountainous area. The northern sub-region is the most important for the beef sector; about 10.2% of the national stock (with 75% at the northern sub-region) are found in this zone.

Geo-climatic zones of Argentina and distribution of beef cattle herd in Argentina by region



80% depending on cow nutrition and health status. Calves are commonly weaned at 7 months, weighing between 150kg-175kg. The main output of this activity are calves which are then sold off for rearing and fattening.

Rearing and fattening systems: Rearing of beef animals occurs either solely on pasture or on pasture with supplementary feeding (in most cases with corn or sorghum silage), while fattening is either pasture-based or on grain. In recent years, finishing animals on pasture alone has become less common. Pasture-finished cattle end up on high-quality pasture-often including legumes such as alfalfa, lotus, and red/white clovers. Although most Argentinean cattle are grazed on pasture, in recent years much of the country's traditional pastureland has gradually been replaced by cropland (corn, soybeans, and sunflower). The increase in soybean production, has resulted in the displacement of cattle from traditional production areas such as the Pampa plains to other regions of the country e.g. North East. To maintain beef production on less land, many farmers currently use corn and other feeds for fattening during the last two or three months prior to slaughter.

Producing on pastures on average takes from 12 months to 24 months from weaning to slaughter. The length of the period depends on calf-weight after weaning, final target weight and average daily weight gain. On the pure grazing systems the fastest cycle takes 12 months from weaning to slaughter, with average daily weight gains of 400-600g per day. In the rearing phase, weaned calves gain on average an additional 125-215 kg of extra weight over 4-18 months depending on the type of rearing. Confinement feeding in feedlots takes place at the end of the rearing phase taking between 2 to 7 months and are characterized by higher daily weight gains ranging from 0.9kg/day to 1.25kg/day. Final weights of steers vary between 330kg to 480kg with heavier animals being produced for the export market. Domestic markets on the other hand have a preference for lean and lighter carcasses. Argentineans continue to demand cuts from young, light, small cattle, typically heifers and steers weighing around 350 kg live-weight. This method is less efficient, but the perception of local consumers is that only beef from small-sized cattle is tender and the preference is for beef from heifers.

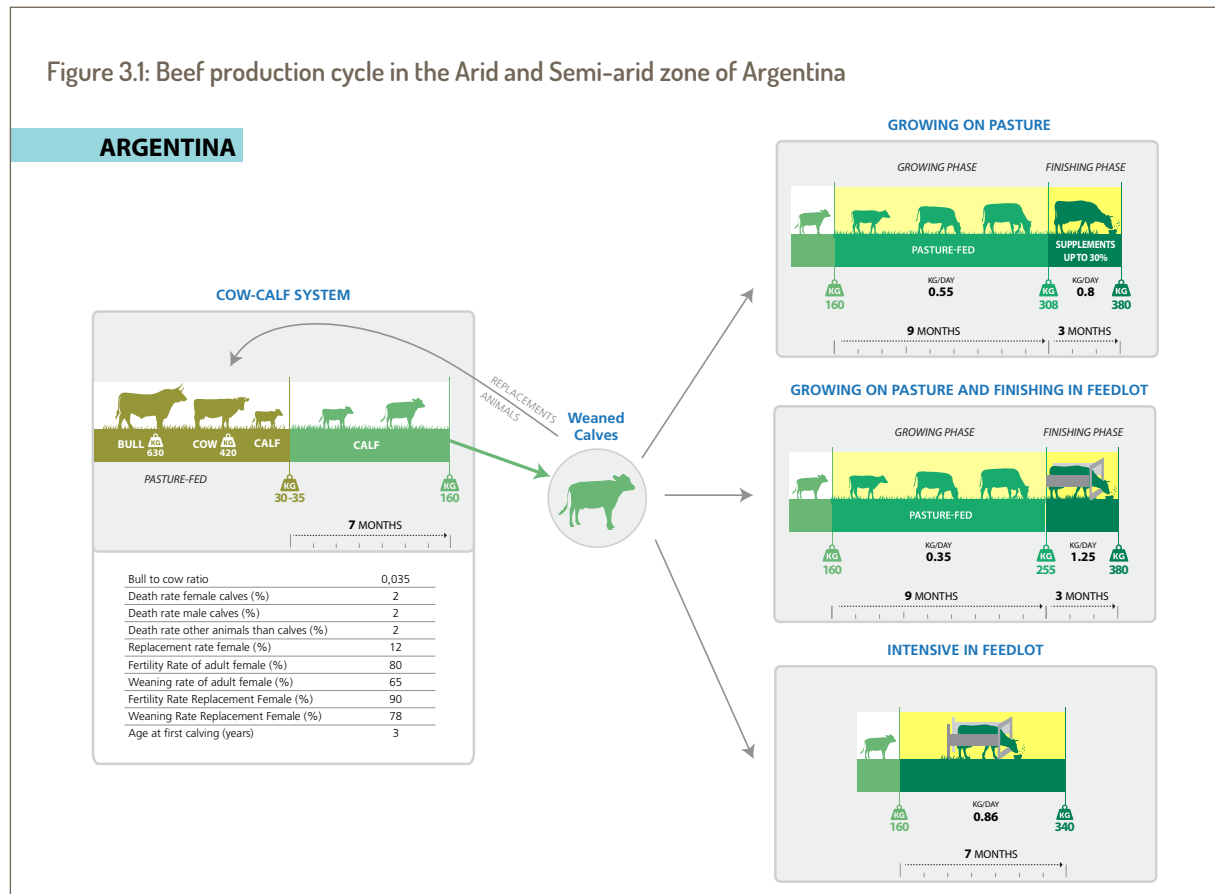
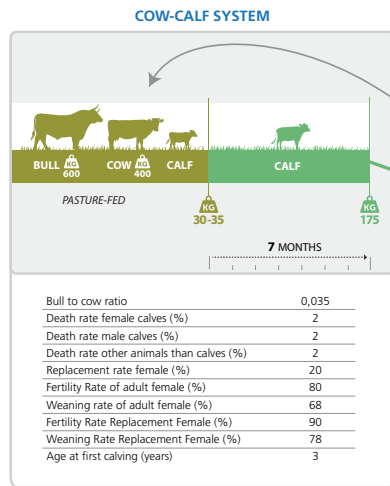


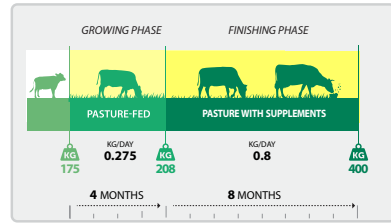
Figure 3.1: Beef production cycle in the temperate zone of Argentina

ARGENTINA

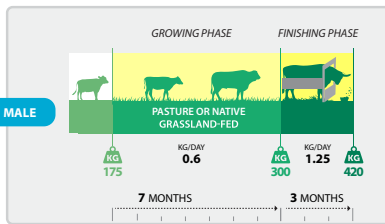


Weaned Calves

INTENSIVE GRAZING WITH SUPPLEMENTS



GROWING ON PASTURE AND FINISHING IN FEEDLOT



GROWING ON PASTURE AND FINISHING IN FEEDLOT

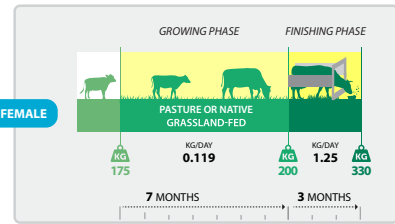
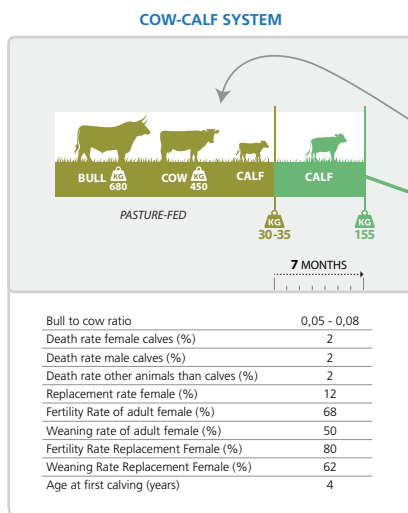


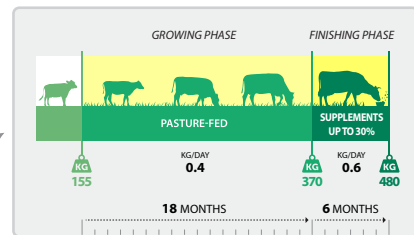
Figure 3.1: Beef production cycle in the sub-tropical zone of Argentina

ARGENTINA

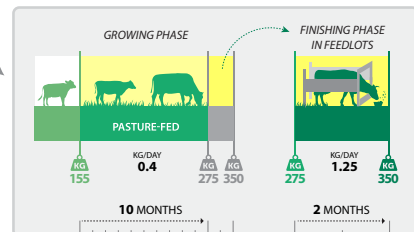


Weaned Calves

EXTENSIVE PASTURE FED



REARING ON PASTURE AND FINISHING IN FEEDLOT



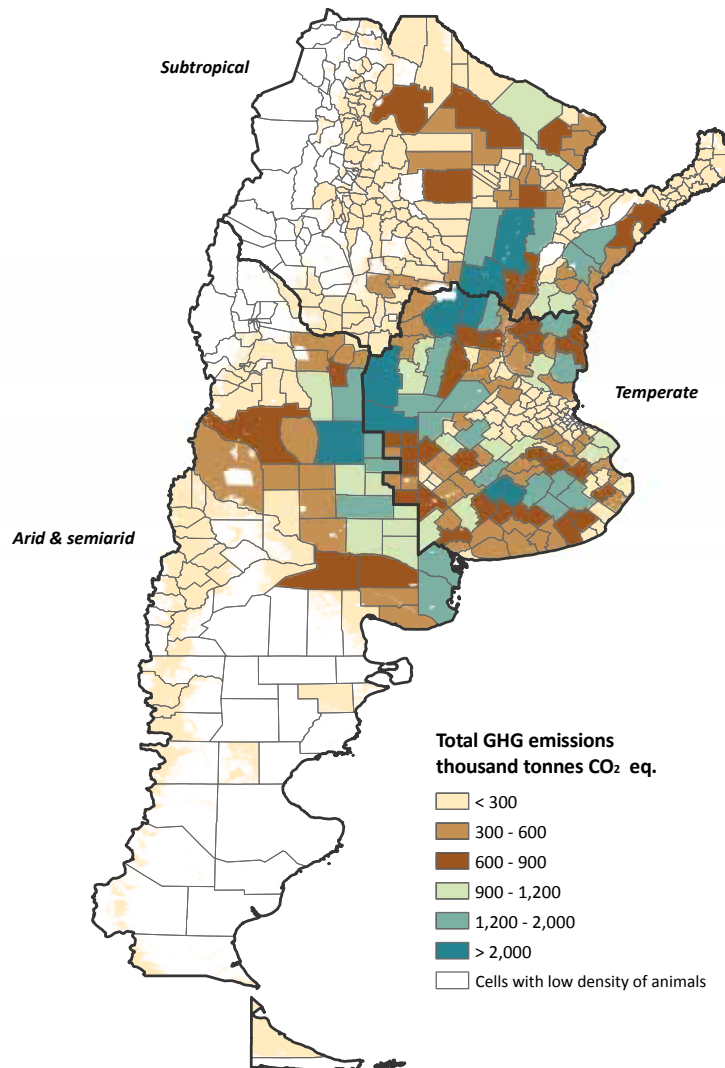
CHAPTER 4

Emissions and emission intensities from the beef sector

This assessment indicates that the Argentinean beef sector is responsible for 169 million tonnes CO₂ eq. Map 4.1 shows the distribution of emissions; distribution of total emissions across the agro-ecological zones is also closely related to

the distribution of beef herd; about 52% of the emissions are found in the temperate zone while 28% and 20% of the emissions are from beef cattle raised in the sub-tropical and arid and semi-arid zones, respectively.

MAP 4.1: Total greenhouse gas emission from beef production



Source: GLEAM, 2017

The GHG profile is dominated by methane 63%, followed by nitrous oxide (36%) and carbon dioxide from fossil fuels (1%). Methane from enteric fermentation and nitrous oxide from manure deposited on pasture contribute the bulk of emissions from beef production; 62% and 35%, respectively (Figure 4.1).

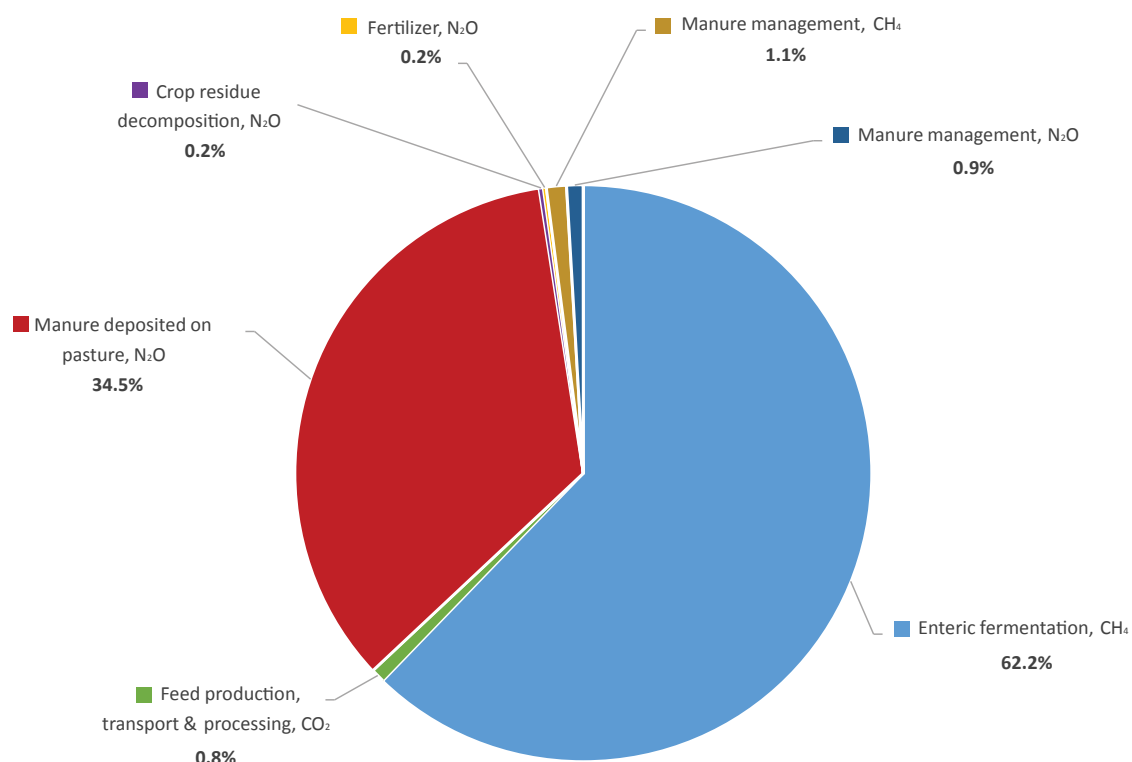
Production system contribution to the total GHG emissions

Figure 4.2 presents emissions in absolute terms disaggregated by beef production system and sources of emissions. The cow-calf systems are responsible for a large share of total GHG emissions; cow-calf system contributes 85% of total emissions, while the rearing and fattening system contributes 13%. Cattle raised and fattened in feedlots are responsible for 2% of the total emissions. (Figure 4.2).

In relative terms, enteric fermentation makes the

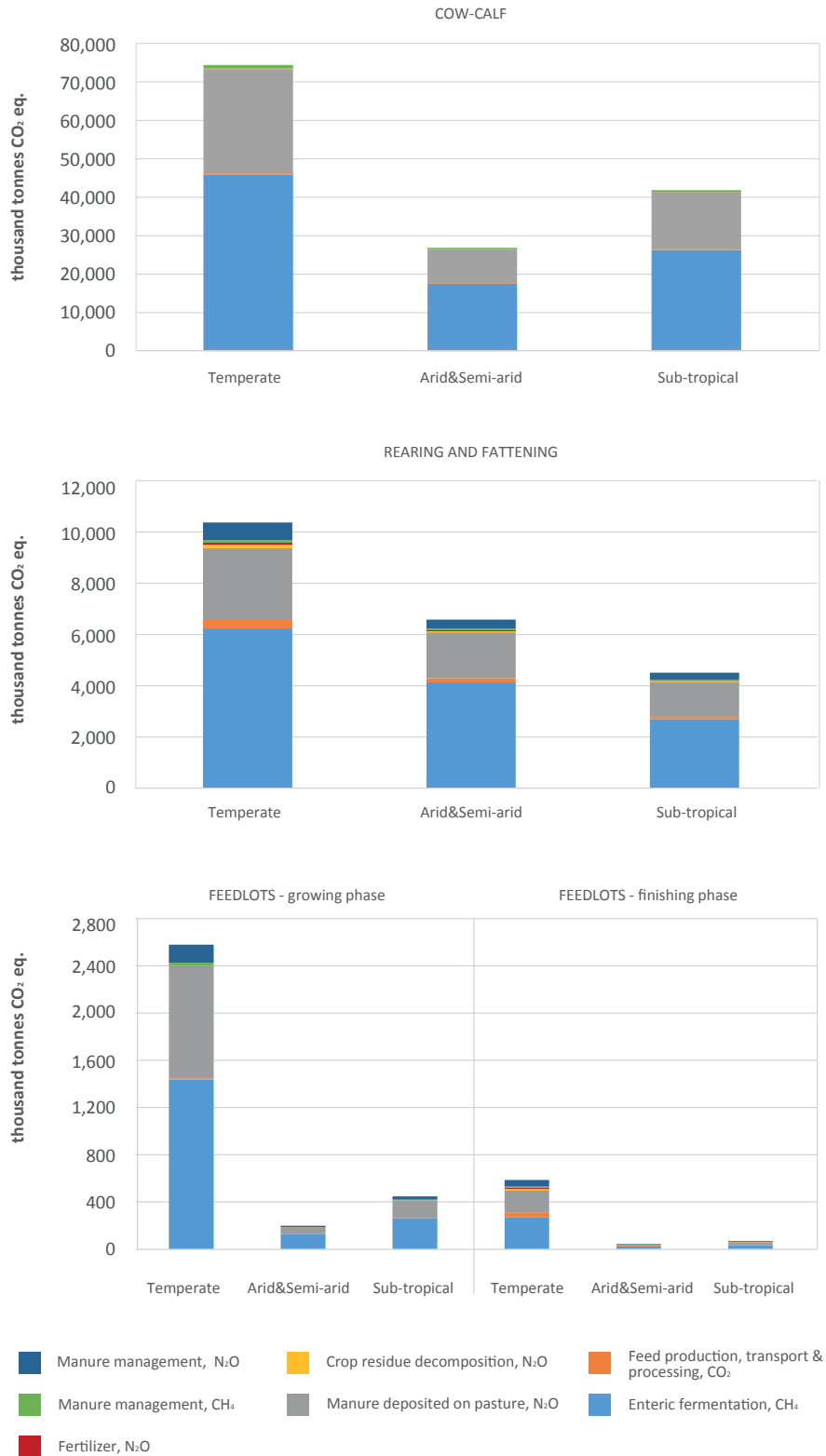
largest contribution to the total: on average 62% (with a range of 55%-63%) of emissions, followed by emissions from manure deposited on pasture, with an average of 34.5%. Owing to the extensive nature of the cow-calf systems, CO₂ emissions associated with feed production, fertilizer production and use, are generally insignificant. However, as production intensifies, the share of emissions from enteric methane reduces and there is a shift towards other emission sources. Increased grain finishing explains most of the observed increase in CO₂ emissions as a result of external inputs for feed grain production and feedlot operations. Fossil fuel energy demand also increased in response to intensification of production on grazing land, observed from the increase in energy intensive inputs e.g. fertilizer application on improved pastures and use of supplementary feed use in the finishing phase.

Figure 4.1: Share of total GHG emissions by emission source



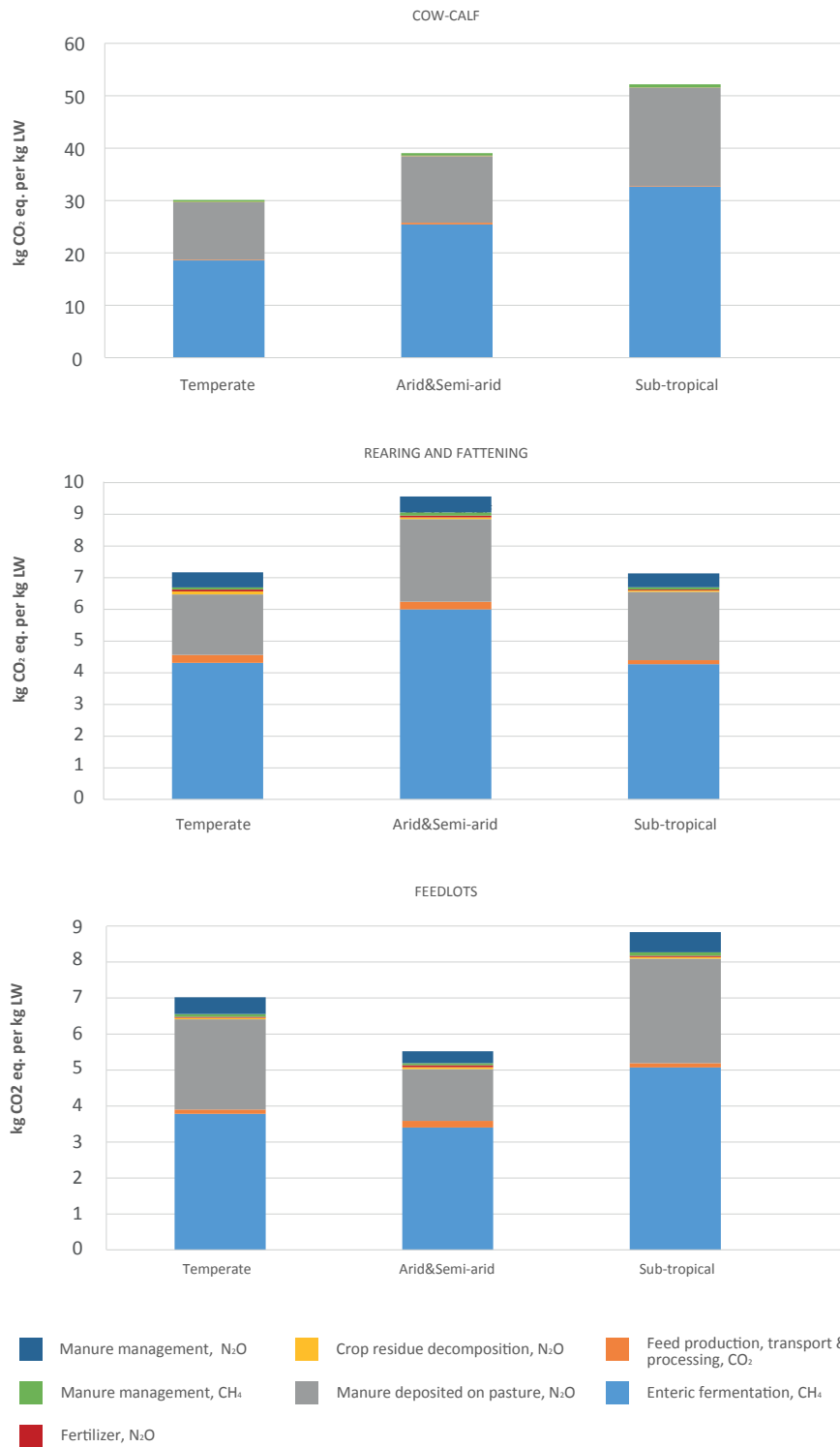
Source: GLEAM, 2017

Figure 4.2: Total GHG emissions by production system and emission source



Source: GLEAM, 2017

Figure 4.3: Average emission intensity per kg live-weight, by production system and agro-ecological zone



Source: GLEAM, 2017

Greenhouse gas emissions per kg of live-weight (LW)

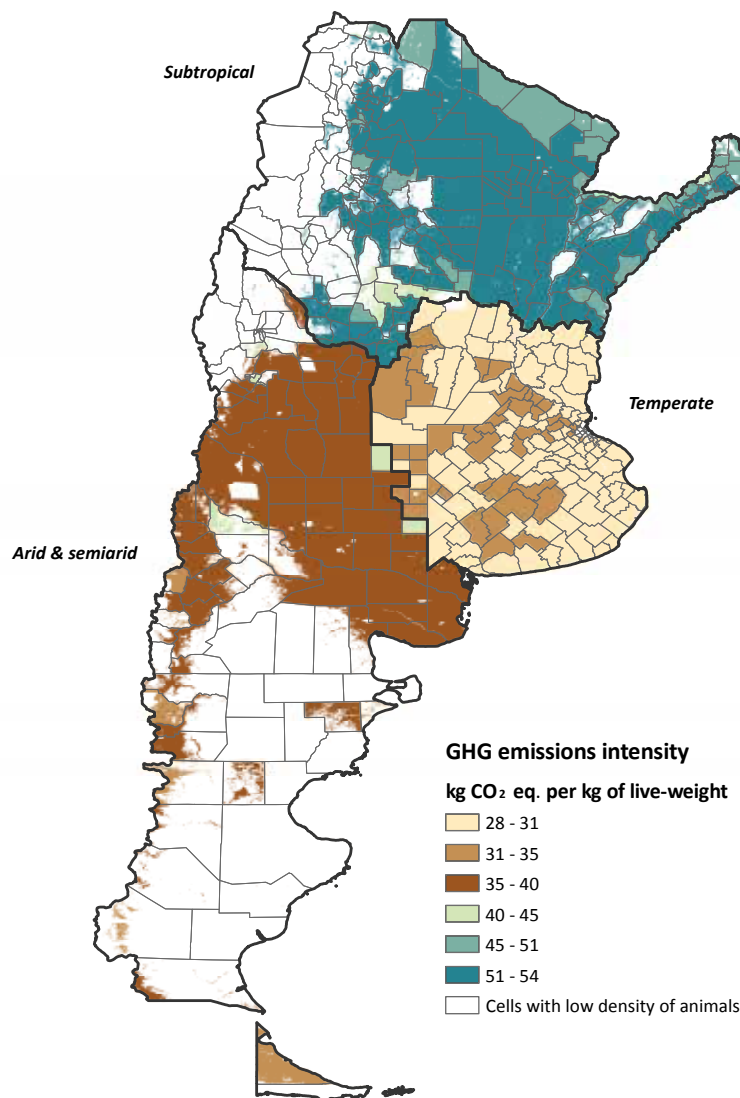
Emission intensity per kg LW is lower as systems intensify, with the highest values estimated for low-input cow-calf systems and the lowest in fattening in feedlots. On a product level, emission intensity were on average 36.1, 7.8 and 7.1 kg CO₂ eq./ kg LW for cow-calf, rearing and fattening and feedlot systems, respectively.

Emission intensity was also found to vary across agro-ecological zones within the same system: 30 kg CO₂ eq./kg LW, 39 kg CO₂ eq./kg LW and 52 kg CO₂ eq./kg LW for cow-calf systems in the temperate, arid/semi-arid and sub-tropical zones, respectively.

Map 4.2 illustrates the emission intensity variability in cow-calf system. The lower emission intensity for animals produced in the temperate zone is due to the higher daily weight gain of calves and the better reproductive status of the breeding herd (higher fertility rates, weaning rates, and age at first calving) compared to the other regions (see Figure 3.1-3.3)

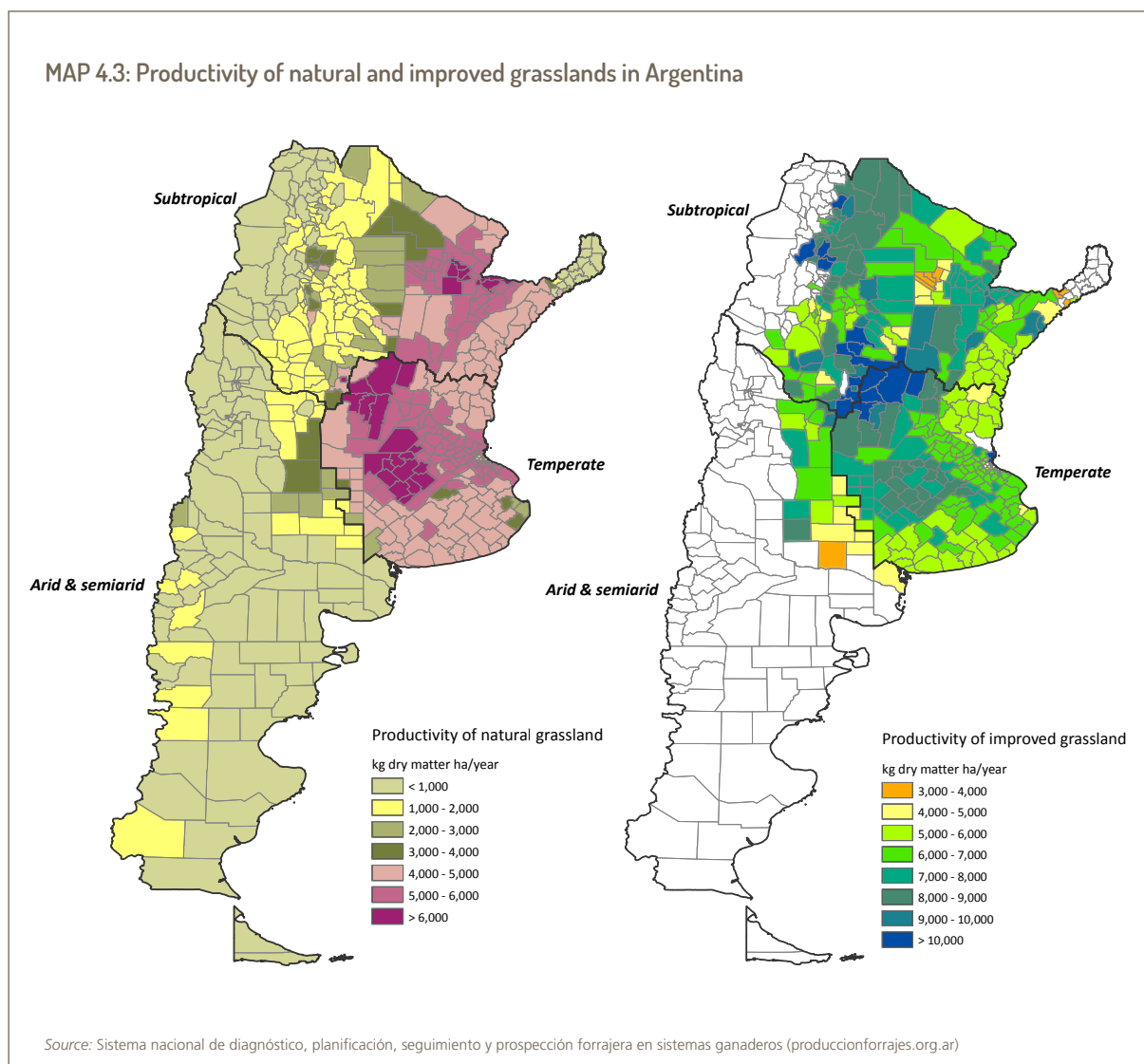
Average GHG emissions per kg of LW in the rearing and fattening phase were: 7.2 kg CO₂ eq./kg LW, 9.6 kg CO₂ eq./kg LW and 7.1 kg CO₂ eq./kg LW in the temperate, arid/semi-arid and sub-tropical zones, respectively (Figure 4.3).

MAP 4.2: Emission intensity in cow-calf systems



Source: GLEAM, 2017

MAP 4.3: Productivity of natural and improved grasslands in Argentina



Determinants of emissions and emission intensities

A number of herd management factors have been identified as influencing emission intensity from beef production. In *cow-calf systems* the following factors have been identified:

Inadequate and poor nutrition i.e. the low supply of high quality pastures. Of the 18.9 million ha of grassland for livestock production, 95.5% is natural grassland (AACREA-FAUBA-INTA-MINAGRI, 2015) and the remaining 4.5% of the grasslands in Argentina are improved grasslands. The vast majority of improved pastures are located in the temperate and sub-tropical zones of Argentina. Despite the relatively small area dedicated to cultivated grasslands (about 4.5% of the surface), cultivated pastures provide 7.4% of the forage offer due to the higher productivity compared

to natural grasslands (Map 4.3). Grass species in native pastures are characterized by low yields and low crude protein (CP) contents. The bulk of feed rations for breeding cows raised in breeding systems is made up of native pastures that is of poor quality (55% digestibility and crude protein ranging between 18-20 g N/kg dry-matter). This has a major influence on reproductive performance and the breeding overhead.

The relatively low calving percentages are largely due to seasonal nutrient deficiencies in pastures and the failure to supplement cows during periods of low nutrient intake. Inadequate nutrition results in delayed rebreeding, later calving dates and a decreased calf-crop percentage. The lack of good management practices of the natural forage resources, the limited use of improved pastures is a key constraint to the achieving productivity goals.

Poor reproductive efficiency: Reproductive efficiency is key to the biological and economic sustainability of beef systems. Improvement in reproductive performance is a major efficiency goal of the beef industry. However, achieving this goal is hampered by a number of other factors particularly feed availability and quality. Poor reproductive performance is manifested in a number of parameters such as:

- low weaning rates; between 50%- 68%, implying that between 32%-50% of the cows in a given year are not producing a weaned calf.
- low fertility rates; especially in the sub-tropical zone with an average of 68% compared to 80% in the other climatic zones). These relatively low fertility rates are due to seasonal nutrient deficiencies in pastures and the failure to supplement cows during periods of low nutrient intake. As a result, cows are unable to rebreed readily.
- delayed time to puberty and age at first calving; 3 years in temperate and arid zones and 4 years in sub-tropical zone.
- weaning weights range from 175 kg in the temperate zone to 160kg and 155kg in the arid/semi-arid and sub-tropical areas. The heavier weaning weights in the temperate zone corresponded with higher daily weight gains for the calves, almost 0.7 kg/day compared to 0.58 kg/day and 0.61 kg/day in the sub-tropical and arid/semi-arid zones.

The improvement in reproductive efficiency has the potential to benefit the economic and environmental impacts of beef production through increasing the percent of cows that produce a calf each year.

Large breeding overhead: Breeding stock (cows, bulls, and replacements) represent about 55% (in arid/semi-arid and temperate zones), and 58% (in sub-tropical zone) of the herd. Because heifers are consuming feed and producing GHG emissions before they reach calving age, advancing heifer development and lowering age-at-first calving can increase production efficiency and decrease the amount of GHG emissions per unit of beef.

In the rearing and fattening systems, long and inefficient rearing and finishing periods particularly for animals finished on natural pastures: The inadequate forage supply from poorly managed natural pastures results in low growth rates of animals meaning that animals have to be retained longer to reach target weights. High average daily gains are compatible with high production efficiency and profitability. Achieving higher growth rates leads to a higher final weight at finishing and/or lower finishing age and means more beef and less emissions relative to the length of time the animal is on the farm producing emissions.

CHAPTER 5

Exploring the mitigation potential in beef production

The analysis of current production of beef in Argentina shows that there is scope to improve beef productivity within the existing systems. This approach to mitigation is compatible with the national objective of increasing overall beef output for improved nutrition and food security. The abatement technologies and practices assessed in this study were selected for their potential impact on enteric CH₄. This is not a purely technical process but incorporates other factors such as current national priorities. As such other considerations taken into account during the selection of interventions was the need to integrate mitigation with a number of key developmental goals for the beef sector, such as their role in promoting food security, rural and overall economic development.

The mitigation options evaluated in this study were selected in a consultative process with national

experts where those options identified as having the potential for large improvements in productivity were assessed alongside their potential to reduce on-farm greenhouse gas intensity while taking into account the feasibility of implementation. Box 3 summarizes the criteria used to identify interventions for inclusion in the analysis.

Enhancing animal productivity has several dimensions including animal genetics, improved feeding, reproduction, health and overall management of the herd. The interventions evaluated covered the areas of nutrition, herd health and management. These comprised: seeding and sowing pasture, fertilization of natural and cultivated pastures, use of conserved fodder and deferred forage, strategic supplementation of breeding cows and growing and fattened cattle, control of reproductive diseases and controlled mating. Interventions were select-

Table 5.1: Summary of selected intervention for Argentinean beef systems

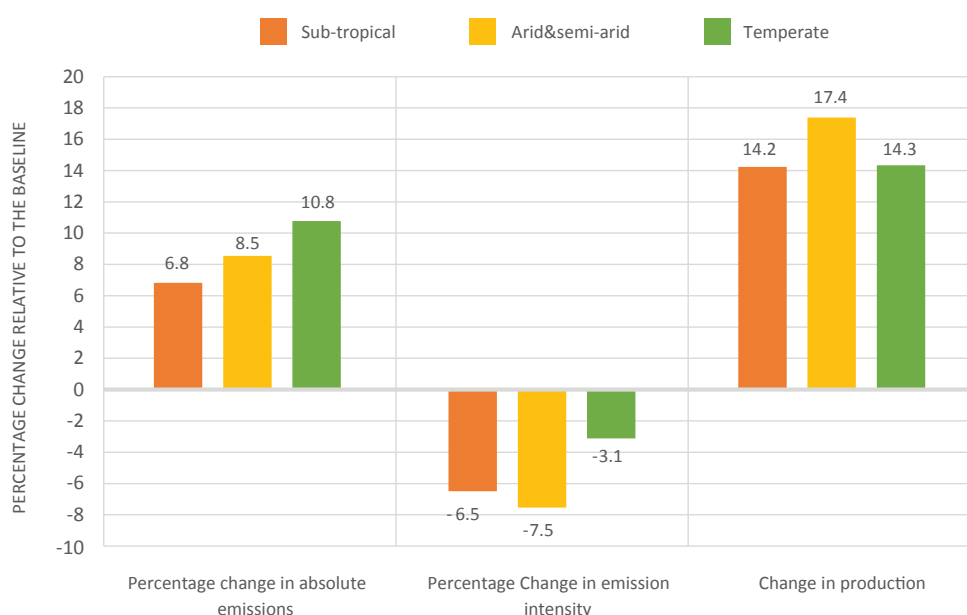
Selected interventions	Objective and constraint addressed	Mode of action
Seeding and sowing of pastures	Improve nutritional status of breeding herd by increasing forage supply and quality especially during periods of low forage production	Improvements in digestibility lead to increased dry matter intake and energy availability, and decrease CH ₄ emissions per unit of product
Fertilization of natural pastures and cultivated pastures		
Use of conserved fodder (hay, silage)	Addresses the lack of sufficient and quality feed resources (especially in winter) and sub-optimal pasture management	
Use of deferred forage		
Strategic supplementation of grazing cows		
Control of reproductive diseases (<i>bovine trichomoniasis</i>)	Improve health and reproductive performance of breeding animals	Enhanced animal productivity and reduced CH ₄ /kg live-weight
Controlled mating – defined breeding season	Synchronize pasture and supplement availability with the breeding cycle to better manage herd nutrition, cow-calf health, closely monitor breeding and calving	Reducing wastage (e.g. involuntary culling, empty reproductive cycles) at the herd level and reduces CH ₄ /kg live-weight
	Addresses the mismatch between forage offer and nutritional requirements of the herd	
Strategic supplementation of growing and fattened cattle	Accelerate growth and shorten growing and finishing periods	Shorter finishing periods and/or higher slaughter weights
	Addresses seasonal energy and protein deficiency	Enhanced animal productivity and reduced CH ₄ /kg live-weight

Box 3: Criteria for selection of interventions

Three principal criteria were used to identify interventions for analysis in the study; the potential for improving production efficiency, feasibility of adoption by farmers and the potential to reduce enteric methane emission intensity. *Improving production efficiency* is a strategy that farmers can implement for mitigation to decrease methane. Using this approach comprises the adoption of effective management of forage and other feed resources e.g. supplementation, ration balancing. Additional strategies that improve animal productivity include fertility and reproductive management of the herd, selection of animals for improved production and improved management of herd health.

Reduction in enteric CH₄ emission intensity: Many measures that have the potential to increase productivity are associated with increased individual animal performance and this increased performance is generally associated with a higher level of absolute emissions (unless animal numbers are decreasing) but reduced emissions intensity. For example, the fertilization of pastures will lead to an increase in absolute emissions not only as a consequence of increased use of synthetic fertilizer but also an increase in enteric methane emissions which results from higher animal performance as a consequence of increase in dry matter intake (figure below). Some interventions will however result in a decrease in both absolute enteric emissions and emissions intensity.

Fertilization of natural pastures: Impacts on total emissions, emission intensity and beef production



Source: GLEAM, 2017

Feasibility of implementation: The third criterion is that the interventions had to be feasible in the short or medium term. For the purposes of selecting interventions, “feasibility” was first determined by sectoral experts in terms of their technical potential, production system and territorial applicability, and market development. The study also assumed reliance on existing and proven technologies. The selected interventions were discussed with a broader group of stakeholders to assess the social and institutional feasibility of adoption and up-scaling of

interventions. Ensuring that this criterion was met also required investigation of information on barriers that prevent farmers from adopting these interventions on a large scale. Other aspects taken into consideration with regard to feasibility included: location of interventions should be informed by location-specific determinants e.g. soil type, and potential to enhance other benefits, e.g. raising income of target population (poverty reduction), biodiversity conservation, and provision of ecosystem services.

ed to address the known key drivers of low productivity and inefficiencies in production cycle. These are summarized in Table 5.1.

The interventions were not applied uniformly, but selected for each production system, animal category, and agro-ecological zone using evidence from modelling and field studies, expert judgement of their specific operating conditions and performance.

Quantitative summary of mitigation outcomes from application of single interventions

The potential outcomes (emission reductions and productivity) from the application of the single interventions considered in this report are presented in Figure 5.1. Overall, the analysis shows that there is a high potential to reduce emission intensities; methane emission intensity (kg CH₄/kg LW) can be reduced by 3% to 39%, the magnitude of the reduction will depend on the intervention and production system assessed (Figure 5.1). The productivity outcomes are presented in Figure 5.1; all interventions returned a positive productivity outcome with increases in production ranging between 2% - 65%.

Sowing and seeding of pastures as an intervention to improve access to adequate and quality fodder results in a reduction in enteric CH₄ emission intensity of 7.4% and 7.7% in sub-tropical and temperate zones, respectively and 9.4% in the arid and semi-arid areas. The intervention was applied only to the cow-calf system and a sub-set of the animals in the herd, more specifically pregnant females and replacement females. Grazing on improved natural pastures results in adequate body weight and body condition of the cows that promote good reproductive indexes (e.g. higher weaning rates) and earlier conception (reduced age at first calving).

The fertilization of natural and cultivated pastures aimed at increasing forage production in cow-calf systems resulted in a reduction potential of 6.8%, 7.9% and 3.4%, in the sub-tropical, arid/semi-arid, and temperate zones, respectively. Given the current low adoption rate (currently no fertilizer is applied on natural pastures and about 30% of the cultivated pastures are fertilized), a 50% adoption rate was assumed. The increase in forage production results in higher animal performance

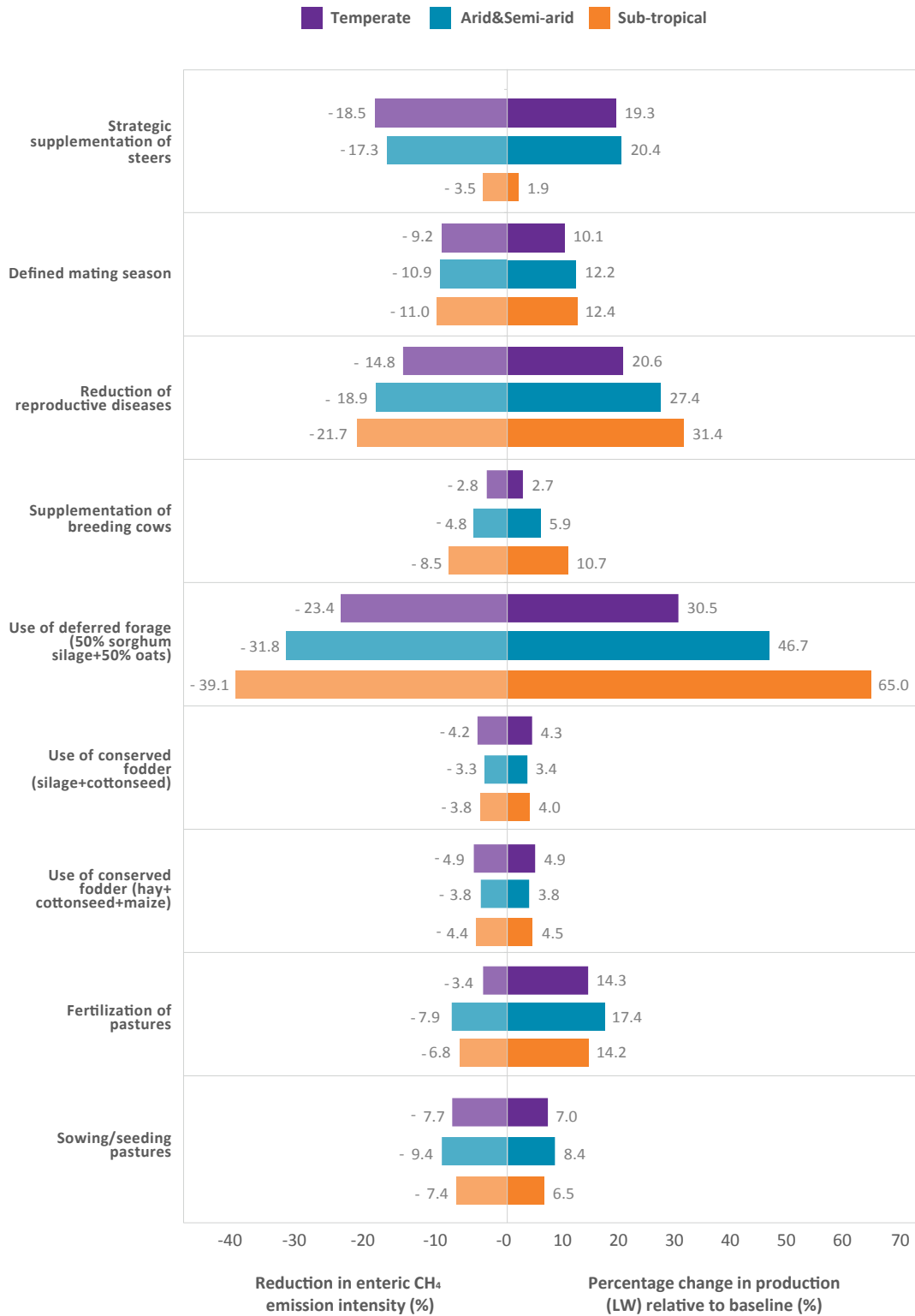
(improved reproductive performance and higher weight-gains). As a consequence of the increase in dry matter intake, the increased weight of the animals, enteric methane emissions increase which explains the modest reduction in enteric CH₄ emission intensity.

Availability of fodder throughout the year is essential for profitable beef production; however in Argentina, fodder availability is affected by seasonality. Conservation of forage in times of surplus is a feed management strategy that can be used to fill feed-gaps in periods of deficit as well as shorten the time spent on the farm of unproductive cows. In this intervention, 100 days prior to marketing, mature and unproductive cows were fattened on a diet of conserved fodder (silage and hay) in combination with supplementary feed (cottonseed meal and maize). The reduction potentials achieved for the two interventions range between, 3.3% - 4.9% (Figure 5.1) relative to the baseline. This change to can be considered conservative because it doesn't take into account the feedback impacts on the rest of the herd that are realized by releasing pasture resources to the other animals in the herd. Fattening and early marketing of unproductive cows results in better pasture utilization and increased efficiency change to the utilization of grasslands by other animal categories.

Deferred grazing is the practice of holding over pasture resources considered surplus to animal requirements in the growing season. It is then grazed at a later date when a shortage of pasture occurs; in Argentina, this is usually in the winter. The aim is to match feed supply to herd requirements using a low cost method of pasture conservation while reducing farm costs. The use of deferred forage combined with supplementation of pregnant cows and replacement females in cow-calf systems resulted in the largest emission intensity reductions of 39%, 32% and 23% in the sub-tropical, arid/semi-arid, and temperate zones, respectively.

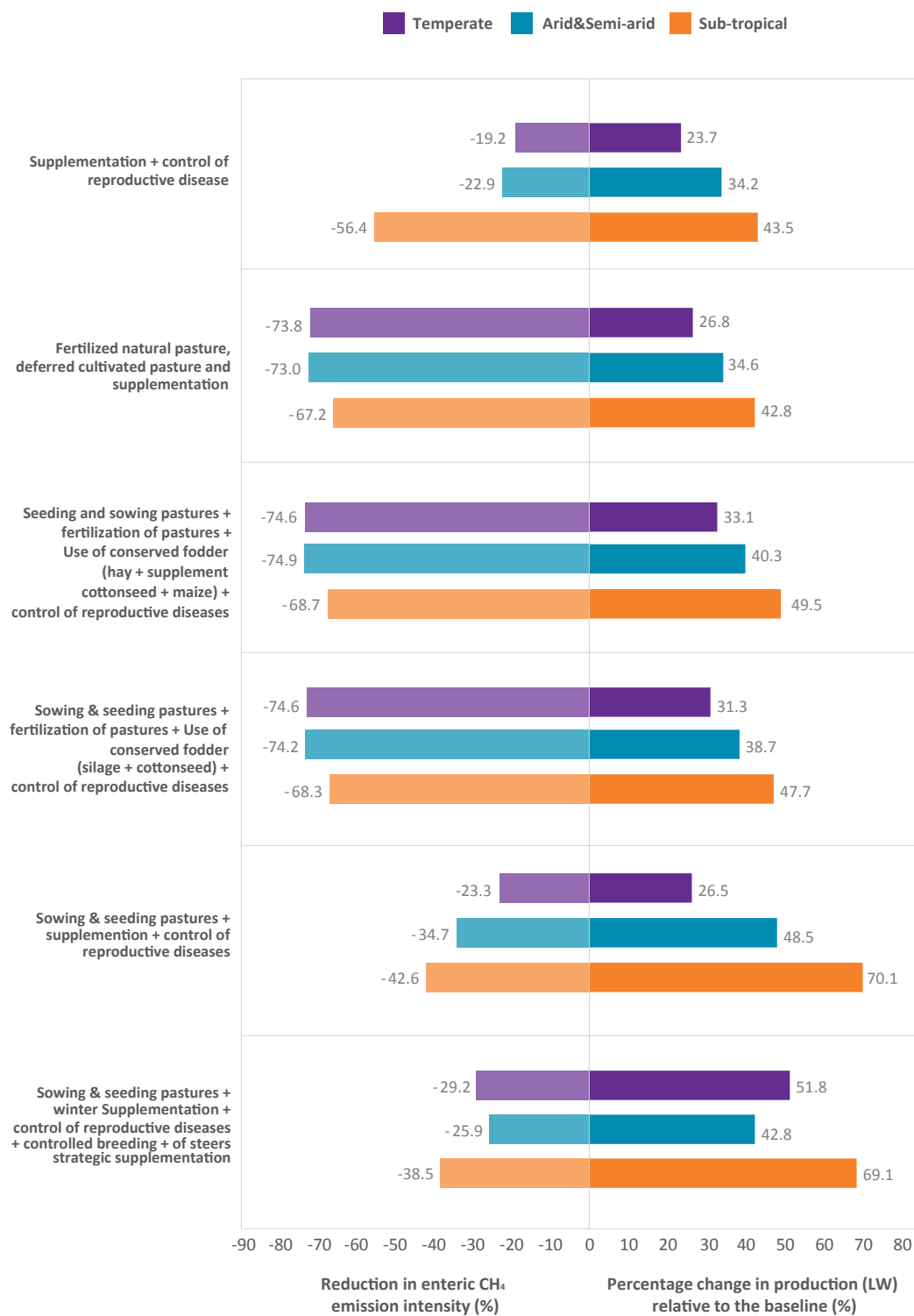
In cow-calf system, the practice of strategic supplementation can be used to achieve different objectives and depending on the animal category targeted. Farmers may use supplementary feeding to maintain weight of cows, improve the growth of heifers, to improve reproductive status of breeding cows, and improve nutritional management of

Figure 5.1: Impacts on single interventions on beef production and enteric CH₄ emission intensity



Source: GLEAM, 2017

Figure 5.2: Packages interventions on beef production and enteric CH₄ emission intensity



Source: GLEAM, 2017

early weaned calves or before extreme weather events and increase the efficiency of the utilization of grasslands. Strategic supplementation is also important during the rearing and finishing phases in order to accelerate growth and weight-gain of steers and heifers and can be used to correct dietary imbalances at different times of the year. Strategic supplementation with cottonseed and sunflower meal was applied to adult female cows and replacement females for a period of 90 days. Enteric methane kg CH₄/kg LW are reduced by 8.5%, 4.8% and 2.8% in cow-calf systems in the sub-tropical, arid/semi-arid, and temperate zones, respectively. Lowest impacts are achieved in the temperate zone where performance parameters are better compared to the other two regions.

On the other hand, strategic supplementation of steers for 90 days resulted in a 17.3% and 18.5% reduction in enteric methane kg CH₄/kg LW in the arid/semi-arid, and temperate zones, respectively. In the sub-tropical zone only a 3.5% reduction is achieved; this is because with this intervention only a 2% increase in production is achieved due to the small change in slaughter live-weight compared to the baseline.

Reproductive diseases reduce the fertility of infected animals or cause losses (abortions) resulting in fewer calves born, and a reduced calving percentage. Implementing a proper bull control program will improve the health status of the breeding herd. Controlling reproductive diseases can increase productivity by reducing losses of calves during gestation and increasing the number of calf produced and weaned. This work shows that controlling reproductive diseases such as *trichomoniasis* can reduce emission intensity by 21.7%, 20% and 15% in the sub-tropical, arid/semi-arid, and temperate zones, respectively.

Controlled mating is a practice that concentrates calving in a limited time for better herd management and aims to achieve higher percentage of weaning and heavier calves, affecting as little as possible the cow's fertility for the next service. It also allows farmers to have better management of herd health as well as better manage available forage resources better. Reductions achieved with this practice are 11% in the sub-tropical and arid/semi-arid zones and 9.2% in the temperate zone.

Quantitative summary of mitigation and productivity outcomes from application of mitigation packages (combined technologies)

Significant reductions in emissions can be achieved through a combination of herd and health management, nutrition and feeding management strategies, and genetics. The reality is that farmers are likely to combine technologies and will select the combination of technologies that will maximize a number objectives and address multiple constraints to productivity. The joint impacts realized from applying a combination of technologies are better understood as multiplicative rather than additive i.e. they are mutually enhancing and dependent.

Applying packages of interventions aimed at improving fertility and reproductive status of the herd; improving feed quality and availability and herd management practices can potentially result in a reduction potential of 19%-60% in emission intensity relative to the baseline emission intensity (Figure 5.2). With these combinations of technologies, an increase in production (expressed in live-weight terms) of between 24%-70% can be achieved compared to the baseline situation (Figure 5.2).

CHAPTER 6

Prioritization of interventions to address enteric methane

Having identified and assessed the mitigation potential, the next step was to prioritize these technologies for wider dissemination and adoption. Prioritization should not only consider enteric methane mitigation potential but also the productivity benefits, income advantages to farmers and other co-benefits that are likely to provide additional incentives for farmers to adopt mitigation interventions. A key incentive to farmers for adoption is increased revenue and/or re-

duced production costs. To better understand the implications for farmers, a cost benefit analysis was conducted to assess the profitability of each intervention. The benefit-cost ratio is the ratio between the present value of the benefit stream and the present value of the cost stream. It provides an indication of how much the benefits of an intervention exceed its costs.

Results from the cost-benefit analysis are presented in Box 4.

Box 4: Assessing the costs and benefits of mitigation interventions

The benefit-cost ratio (BCR), i.e. the ratio of the present value of the benefits to the present value of the costs. Costs were calculated as production costs (baseline scenario) plus costs involving the implementation of the mitigation strategy while benefits were calculated as total revenue from meat output within a year. The benefit-cost

ratio indicates the overall value for money of the interventions. Generally, if the ratio is greater than 1, the intervention is acceptable. In this study the, the BCR for different mitigation options ranged from 2.6 to 4.0 (figure below) indicating that benefits exceed economic costs for the different options under consideration.

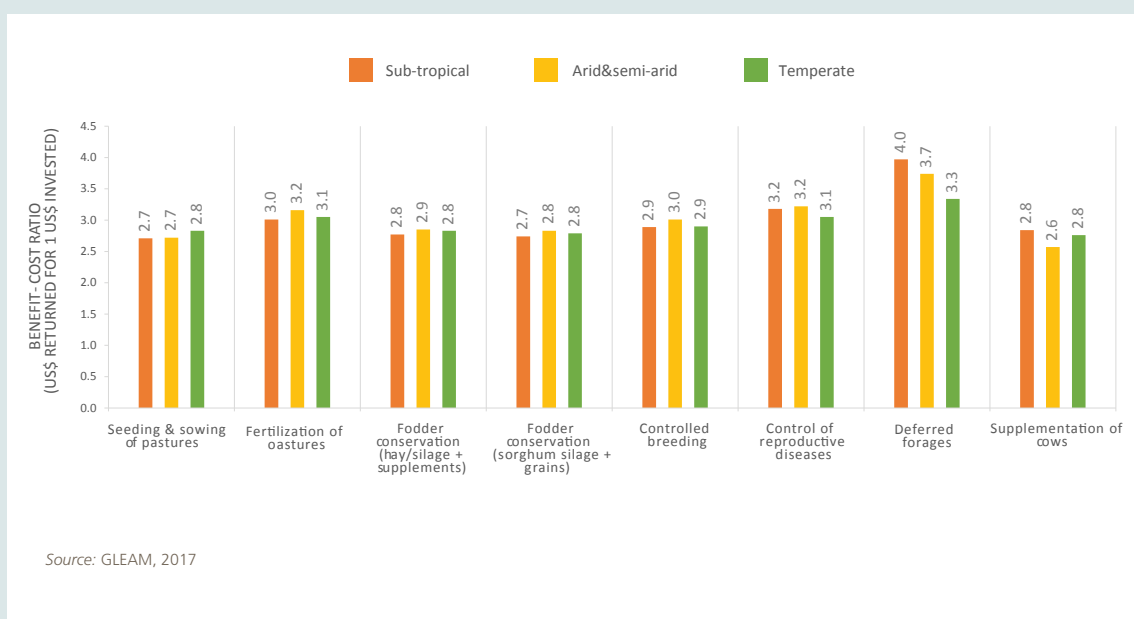
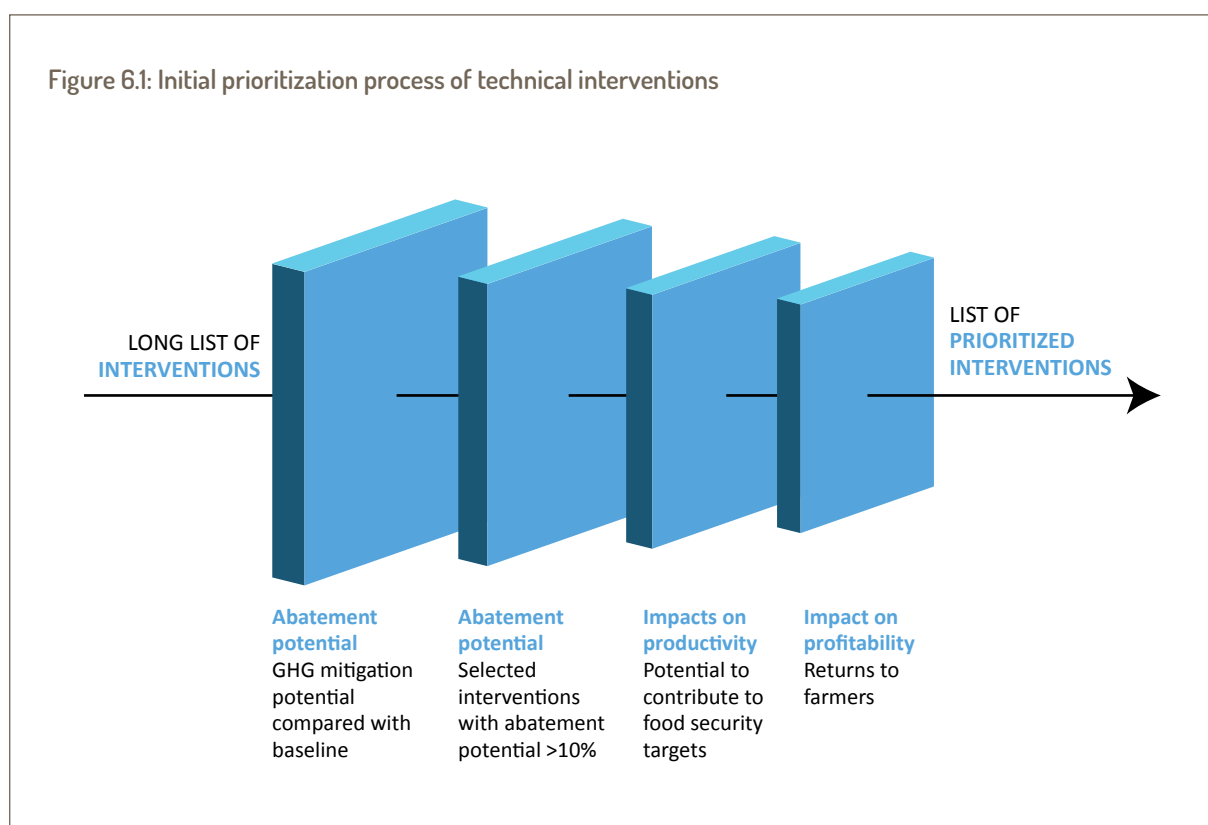


Figure 6.1: Initial prioritization process of technical interventions



The prioritization process

All individual practices were ranked for their ability to reduce enteric methane. Given that there is always uncertainty around any estimation of reduction potential we discarded any practice that would reduce emissions by <10%. This reduces the risk of promoting practices that have marginal or no enteric methane benefit. The remaining practices were then assessed against their enteric methane reduction potential and two other criteria; productivity improvement and economic benefits.

For ease of interpretation a 'coloured light' system was developed for assessing impact where amber was 'high', blue 'medium' and orange 'low'. As the impact of an individual practice varies by system, practices were prioritized separately for each system. The values associated with the high, medium and low classification system are shown at the bottom of Table 6.1. It must be emphasized that this system was developed as an aid to more easily identifying those practices with the highest potential both within and between practices and systems. It does not signal potential since even practices ranked 'low' against all three criteria reduced enteric methane emissions, increased output and returned a net financial benefit.

The outcomes of the prioritization process are shown in Table 6.1.

Summary of prioritization of interventions

Comparison of individual interventions: A number of interventions applied to the cow-calf system (seeding and sowing natural pastures, fertilization of pastures, use of conserved fodder and supplementation of breeding cows) were excluded because they did not meet the minimum criteria of achieving enteric methane reductions greater than 10 percent (see Figure 5.1). Based on this initial screening, only 4 individual interventions (out of the 8 selected interventions) were included in the prioritization process.

All 4 individual interventions included in the prioritization process resulted in increased production when compared across all agro-ecological zones; the largest productivity gains were achieved for increased use of deferred forage and reduction in reproductive diseases. Use of deferred forage in cow-calf systems was ranked high in the three agro-ecological zones. All 4 individual interventions returned a positive benefit-cost ratio irrespective of system and, in general, those with the highest in-

crease in production returned (i.e. use of deferred forage) had the highest benefit: cost ratio (Table 6.1).

System level and agro-ecological comparisons: The results from this study show that the impact of the modelled interventions was greater in the cow-calf systems in the sub-tropical and arid/semi-arid zones. This was generally true for all assessment criteria and was particularly striking for economic benefit where all interventions were ranked ‘high or medium’ (Table 6.1).

When assessed against the three criteria and across all cow-calf systems in the three agro-ecological zones, the use of deferred forage and control of reproductive diseases are the practices that look to have the highest potential to balance decreases in enteric methane with increased food supply and returns on investment.

Defining a mating season in grass-based systems scores

low in terms of methane reduction and productivity gains and has moderate impacts in all production systems which is largely related to low cost associated with the intervention and the increase in calves weaned. The impacts on CH₄ and beef production are low across all AEZs because the largest gain from the application of this intervention is manifested through increased number of calves born and weaned. The number of weaned calves (in live-weight terms) increased by 18% but given the low weights (155-175 kg), the impact on live-weight production is modest. Secondly, the reductions in methane emissions are marginal because calves are considered not to produce methane emissions.

Intervention packages

The large number of possible intervention ‘packages’ ruled out a comprehensive comparison and prioritization of alternative ‘packages’. Expert judgment

Table 6.1: Results from the prioritization of single interventions for beef production systems

Practice	COW-CALF			FATTENING
	Use of deferred fodder	Control of reproductive diseases	Controlled mating season	Supplementation of steers
TEMPERATE				
Methane reduction	●	●	●	●
Production increase	●	●	●	●
Economic benefit	●	●	●	●
ARID AND SEMI-ARID				
Methane reduction	●	●	●	●
Production increase	●	●	●	●
Economic benefit	●	●	●	●
SUB-TROPICAL				
Methane reduction	●	●	●	**
Production increase	●	●	●	
Economic benefit	●	●	●	

** Impact on methane emissions less than 10%

Assessment criteria:

- Methane mitigation: ● Low: >10 <25 ● Medium: >25 <50 ● High: >50
- Production increase: ● Low: <10 <25 ● Medium: >25 <50 ● High: >50
- Economic benefit: ● Low: <2.5 ● Medium: >2.5 <3.5 ● High: >3.5

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was therefore used to define what was deemed the most appropriate common intervention ‘packages’ to compare across the systems. Table 6.2 compares the impacts of three packages which comprised of a combination of single interventions, against the three assessment criteria. Compared with the individual interventions, enteric methane reduction

was increased while production and economic benefits were maintained or increased.

In all systems and agro-ecological zones the three criteria ranked moderate to high (Table 6.2) reinforcing the benefit from introducing a package(s) of interventions that address a series of productivity constraints.

Table 6.2: Prioritization results for the “packages” interventions for beef production systems

Common intervention ‘package’	Methane reduction	Production increase	Economic benefit
Package 1: sowing and seeding pasture + winter suppl. + reproductive disease control + controlled breeding + supplementation of steers			
Sub-tropical	●	●	●
Arid and semi-arid	●	●	●
Temperate	●	●	●
Package 2: sowing and seeding pasture + fertilization + conserved fodder + reproductive disease control			
Sub-tropical	●	●	●
Arid and semi-arid	●	●	●
Temperate	●	●	●
Package 3: deferred forage+ supplementation + reproductive disease control			
Sub-tropical	●	●	●
Arid and semi-arid	●	●	●
Temperate	●	●	●

Assessment criteria:

Methane mitigation: ● Low: >10 <25 ● Medium: >25 <50 ● High: >50
 Production increase: ● Low: <10 <25 ● Medium: >25 <50 ● High: >50
 Economic benefit: ● Low: <2.5 ● Medium: >2.5 <3.5 ● High: >3.5

CHAPTER 7

Unlocking the ‘no regrets’ opportunities

The cattle sector in Argentina has experienced profound changes over the past few decades. Between 2005 and 2014, the cattle inventory decreased almost 10% (from 57 to 52 million); the main impact was experienced by the cow-calf sector through the reduction in availability of breeding females. This decrease in inventory can be attributed to multiple circumstances, such as an intense drought affecting cow-calf producing areas, low cattle prices, macroeconomic decisions affecting exports as well as domestic trade, and strong stimuli to cultivate high-priced grain and oilseed crops, which has reduced grazing land available for cattle production. Despite this, cattle farming will continue to be a dominant agricultural sector in Argentina, and an important livelihood option for farmers.

The analysis in the preceding sections indicates that there are significant opportunities for growth on a low carbon path for the beef sector and that low-cost (or no) opportunities exist across all production systems. Most notably, these include a range of efficiency enhancing measures such as improving nutrition, animal husbandry and herd health and genetics. While the analysis does not include a complete assessment of the barriers

associated with the adoption of technologies, the magnitude of the identified savings clearly indicates that they are not inaccurate.

Why do these many low-cost opportunities remain untapped? The explanation lies in a variety of barriers that prevent the uptake of such opportunities.

Overcoming barriers to adoption

Although improved technologies and practices can generate substantial public and private benefits, their adoption often faces a variety of socioeconomic and institutional barriers. These include the significant upfront investments and expenditures that are often required to adopt a technology. Necessary inputs may not be available in local markets. Farmers may lack information about the potential gains of adopting a new technology. Some new technologies are incompatible with traditional practices such as supplementation in grazing systems is often a challenge. Capacity to implement new techniques is often limited, and many farmers may have little if any experience with certain technologies. While the factors that determine adoption rates are location specific, a number of them appear to be particularly prominent.

Table 7.1: Identified barriers to adoption of selected interventions

Technology/practice	Access to Inputs	Cost	Farm infrastructure	Training/education/knowledge
Sowing and seeding		***	***	***
Fertilization of pastures		***		***
Fodder conservation		***		
Deferred forage			***	***
Supplementation	***	***	***	
Reproductive disease control				***
Breeding season			***	***

The majority of Argentinean livestock farmers lack the capacity, resources and financial assistance to adapt to economics and market changes as well as overcome challenges such as worsening climatic conditions.

Table 7.1 suggests that high cost of inputs, costs associated with establishment and maintenance, farm infrastructure investment costs, and limited knowledge are important factors limiting adoption. For technologies such as sowing and seeding of pastures, fertilization of pastures, forage conservation that have high up-front investment costs in farm machinery and poor functioning input markets (access to supplementary feed) limits the capacity of farmers to implement new technologies. A number of improved practices and technologies are knowledge-intensive and promoting their adoption is likely to require training and extension.

It is important to note that adoption also depends on policy incentives, technical support, farmers' capacity, and other factors. Putting in place supportive policies and programs to overcome the market, regulatory and institutional barriers is essential for mitigation potential to be realized.

Policy reform to promote growth in the beef sector

In order for the beef sector to continue to be a dynamic factor in the growth of the national policies and incentives.

In the past, agricultural policies have prioritized the role of the sector as: i) a provider of low-priced food; ii) an instrument for limiting inflation in food prices; and iii) a significant source of tax revenues. It did not prioritize its importance in national economic growth, increased exports, job creation or social and economic development. Increasing fiscal revenues through high rates taxes imposed on agricultural products' exports: soy 35%, sunflower seed 32%, wheat 23%, corn and

sorghum 20%, and beef 15% have discouraged production growth especially for those products with export restrictions⁹.

In the case of beef, these measures had the following impacts:

- Loss of export market and reduced competitiveness on international market and loss of revenue for producers and exporters. While beef exports between the years 1995 and 2005 averaged 15% of total beef production, the participation was reduced to 7% in 2014¹⁰. As production and export continued declining, and an estimated 130 slaughter plants and 15,600 jobs were lost.¹¹.
- Notable drop in beef supply (10% decrease in beef production), which in turn created substantial increases in domestic prices of beef.
- Low beef prices led to destocking (higher slaughter of breeding cows) a factor that explains the cattle stock decrease and conversion of land to other profitable products. Cattle stock dropped by more than 10 million heads between 2007 and 2012 (severe droughts and floods added significantly to this decline)¹².
- Decrease in domestic consumption due to reduced supply – from 62 kg per capita in 2005 to 58kg per capita in 2014.
- Argentina is already taking steps towards the deregulation of the sector which has seen the elimination of export quotas and taxes on beef (Box 5).

Better exploiting Argentina's competitive advantage

The historical comparative advantage of Argentina's beef sector is largely a product of its rich resource endowments. In prior decades, the availability of large volumes of land suitable for crop cultivation and pasture helped to transform agriculture and cattle farming into key sectors for sustaining the country's economic growth. In Argentina, in the last two

⁷ Fernández, O. A., and C. A. Busso. 1999. Arid and semi-arid rangelands: Two thirds of Argentina. Pages 41–60 in Case Studies of Rangeland Desertification. Arnalds, O., and Archer, S., ed. Agricultural Research Institute Report 200, Reykjavik, Iceland.

⁸ D. H. Rearte 2007. La producción de carne en Argentina. II. Programa Nacional de Carnes. Instituto Nacional de Tecnología Agropecuaria, Buenos Aires, Argentina.

⁹ Regúnaga, Marcelo; Tejada Rodríguez, Agustín (2015). Argentina's Agricultural Trade Policy and Sustainable Development; Issue Paper No. 55; International Centre for Trade and Sustainable Development, Geneva, Switzerland, www.ictsd.org

¹⁰ Ministerio de Agroindustria de Argentina (MINIAGRI) (2015). Ministerio de Agroindustria de Argentina. Indicadores bovinos anuales 1995-2015.

http://www.agroindustria.gov.ar/sitio/areas/bovinos/informes/indicadores/_archivos/000001Indicadores/000003-Indicadores%20bovinos%20anuales%201990-2015.pdf

¹¹ <http://en.mercopress.com/2013/05/21/argentina-absorbs-93-of-beef-production-exports-tumble-behind-paraguay>

¹² Instituto de Promoción de la Carne Vacuna Argentina (2015) Estadísticas mensuales. <http://www.ipcva.com.ar/estadisticas>

Box 5: Argentina is already acting

Since 2015, the government has implemented significant macro-economic reforms to encourage the livestock sector to revive after several years of government intervention and low profitability. The main measures implemented include the elimination of export quotas and taxes on beef and the removal of other measures which resulted in the distortion of the domestic beef/cattle market and

negatively affected the sector. The government, has also provided a credit line (at lower interest rates) of some US\$50 million to small and medium-scale livestock producers (including cattle producers) to incentivize and facilitate investment in expanding herds and production while improving product quality.

Source: USDA (2016): Argentina – Livestock and products annual

decades, the livestock area was reduced in favor of increasing the grain cropping area. The increase in land values in Argentina in recent years is a clear indication of the changes in land dynamics. For instance, one hectare of land in a cattle breeding area that was worth US\$200 two decades ago now costs US\$1,800. In the core livestock area of the Argentine Pampa, the cost of one hectare has risen from US\$2,000 in 1990 to US\$10,000 today¹³. Over the years, there has been (i) an increase in cropland area (doubling) and a five-fold increase in crop between 1970 and 2012; (ii) an expansion of cropland at the expense of natural ecosystems (in the North) and; (iii) the displacement of cattle production (mainly cattle) from the Pampa to new areas (Northwest and Northeast) and an increase in cattle raised in feedlots.

Cattle production has shifted from 100% pasture to pasture supplemented with cereal grains and conserved forages, and confinement on grain feeding for fattening period. As pastures are converted to profitable crops, beef producers will have to look for ways to increase remaining pasture productivity in order to meet the targets of increasing productivity. It is likely that the area dedicated to livestock production will continue to decrease, but this should not be viewed as an obstacle to the sector's growth. Increased production will have to come from improved production efficiency of the already existing herd. Public policies and planning would be pivotal, with management of land competition at the center.

Eliminating the demand for more land by the sector would require accommodating the expansion of agriculture and the beef industry—both of which are important to the Argentinean economy—on already existing land. That would mean a drastic increase in productivity per hectare. Technically, one available option is to increase cattle productivity, thereby freeing up large quantities of pasture. This option is technically possible since current average livestock productivity is low and would entail reducing the yield gap and scaling up of already existing productive systems in Argentina.

The potential for recovery of degraded pasture is considerable and is enough to accommodate the most ambitious growth scenario. The cost of land degradation on grazing land on milk and meat productivity has been estimated at about US\$586 million per year or 11% of the livestock gross domestic product¹⁴. Such high losses require immediate action given the increasing demand for livestock products and its potential to simultaneously increase farmer income, sequester carbon, reduce soil erosion, and other ecosystem service benefits. Moreover, moving from lower to higher productivity production systems can trigger a net gain for the sector and economy since more intensive processes converge with higher economic returns.

But this option also presents challenges. First, productive livestock systems are far more capital-intensive, both at the investment stage and in

¹³ IFAD (2011). The issue of land in Argentina: Conflicts and dynamics of use, holdings and concentration. IFAD

¹⁴ Bouza, Mariana E.; Aranda-Rickert, Adriana; Brizuela, Maria Magdalena; Wilson, Marcelo G.; Sasal, Maria Carolina; Sione, Silvana M. J.; Beghetto, Stella; Gabioso, Emmanuel A.; Oszust, Jose D.; Bran, Donaldo E.; Velazco, Virginia; Gaitan, Juan J.; Silenzi, Juan C.; Echeverria, Nora, E.; De Lucia, Martin P.; Iurman, Daniel E.; Vanzolini, Juan I.; Castoldi, Federico J.; Hormaeche, Joaquin Etorena; Johnson, Timothy; Meyer, Stefan; and Nkonya, Ephraim M. 2016. Economics of land degradation in Argentina. In Economics of land degradation and improvement- A global assessment for sustainable development, ed. Ephraim Nkonya, Alisher Mirzabaev, and Joachim von Braun. Chapter 11, pp. 291 - 326. http://dx.doi.org/10.1007/978-3-319-19168-3_11

terms of working capital. Having farmers shift to these systems would require attractive incentives. Second, these systems are knowledge-intensive compared to the traditional extensive beef systems which are generally low-input systems. Therefore,

the support should be accompanied by development of training, extension services, as well as input and output markets. Public policies that promote rural extension and training of cattle ranchers would be important in overcoming this barrier.

CHAPTER 8

Key messages and policy conclusions

This chapter sets out to present key highlights and messages from the analyses. It is not the intention of the chapter to repeat the detailed analysis of previous chapters but rather to draw out some key overarching messages and policy conclusions.

The potential for low-cost abatement is sizable

The existence of technical practices that mitigate GHG emissions underscores the potential of the cattle sector to be part of the solution to climate change. This study helps illustrate how, the beef sector in Argentina can make substantial reductions in emissions with interventions and investments that in many cases will pay for themselves. The analysis demonstrates significant impacts achieved with the application of a combination of tailored packages of interventions; beef production increases between 24% and 70% while reducing emissions by 19% and 75%. This impact is further amplified through the combination of tailored packages of interventions addressing multiple constraints in production.

More importantly, from the study low emissions development of the beef sector can potentially support a range of other national policy goals, including achieving food and nutrition security, economic growth and development, improved livelihoods, and environmental protection. It is this combination of reasons that explains the strong interest of the country to pursue low emissions growth and justifies investment in the sector.

However, achieving these reductions will require ambitious action. Translating the actions outlined in this document into food security and developmental goals will require bolder efforts to support the transfer and uptake of technology, reduce costs of technologies, scale-up private sector finance, and support access to climate finance.

Many interventions will pay for themselves

The strong correlation between productivity increases and methane mitigation demonstrated in this analysis implies large opportunities for low-cost mitigation. The additional benefits and positive economic returns that can be generated by closely aligning emission intensity reductions with productivity gains result in lower abatement costs for producers.

Analysis in preceding sections indicates that while significant low-cost opportunities exist, many still remain untapped. However, it is clear that even win-win interventions still face barriers that require holistic policy action. The reasons for low adoption lie in the numerous barriers that prevent the uptake of these opportunities.

Technology alone is insufficient to achieve the multiple objectives that have been charted out for the Argentinean beef sector. Policies and incentives are required to minimize risks faced by various stakeholders and attract investment capital to the sector.

Public policies are pivotal to harnessing the potential

Argentina harbors large opportunities for mitigation and carbon uptake of GHG emissions at relatively low costs. This positions the country as one of the key players to tackle the challenge posed by global climate change and global food security. This study has demonstrated that a series of mitigation are technically feasible and that promising efforts are already under way (Box 4).

Yet implementing these proposed measures would require large volumes of investment and incentives, which may exceed a strictly national response and require international financial support. Moreover, for Argentina to harvest the full range of opportunities to mitigate GHG emissions, market mechanisms will not be sufficient. Without consistent policy signals, autonomous efforts by farmers are unlikely

to be sufficient to create a sustainable, productive and resilient cattle sector. Where there are market failures, where private costs are lower than social benefits, farmers will not invest enough in mitigation. Moreover, farmers are often faced with conflicting policy signals. Some policies encourage production at the expense of climate change objectives, while other measures try to offset these negative effects. There is a need to identify such inconsistencies and develop a coherent set of incentives for achieving sustainable productivity growth with mitigation and adaptation as part of this effort. Achieving this will require involvement of the private sector, producers and governments, with policy solutions tailored to reflect private and social costs and benefits. Some situations will call for national and international cooperation, others for local or regional initiatives.

Action to address methane must continue to support food security goals, economic growth and other sustainable development goals

Argentina's agricultural sector contributes 7.2% to the gross domestic product (GDP), high in comparison to the 5.2% average in the rest of the Latin America and the Caribbean (LAC) region¹⁵. National agriculture provides key staple foods for the nation's 41 million inhabitants, such as bread, beef, and milk¹⁶. Agricultural exports account for 58% of national exports and feed around 450 million people around the world.

The exclusive focus on methane in the climate debate is short-sighted, if the analysis is confined only to emissions. The opportunity to mitigate methane is only one reason to reduce emissions; reducing emissions of methane can provide significant development benefits,

including improved productivity, food security and livelihoods. This study confirms the often cited multiple synergies that can be achieved by combining measures that address enteric methane with efforts to improve food and nutrition security.

Methane production through enteric fermentation is not only of global concern for its contribution to global warming, but also for its wastage of feed energy, an inefficiency that limits the production performance of ruminants. As a result of this process, ruminants lose between 2-12% of the gross dietary energy in the form of methane, depending on the quality and quantity of diet. Thus, it is essential to look for options to reduce CH₄ emissions through improving feed conversion efficiency, which also translates into higher productivity and improved food security.

Over time, the need to integrate climate change policies into national sustainable development strategies has become more evident as these policies can only be effective when embedded within broader strategies designed to make national development paths more sustainable. There is general agreement that policies pursuing climate change and sustainable development can be mutually reinforcing.

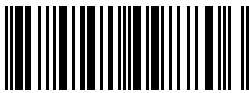
Action to reduce enteric methane is thus important as it provides countries, a critical opportunity to adapt to the challenges of our changing climate. At the same time, reducing enteric methane can reap food and nutritional benefits including other development benefits. This will provide incentive to countries to act responsibly in global climate mitigation, while simultaneously ensuring continued domestic growth.

¹⁵ The World Bank. 2014. Agriculture, value added for Argentina and LAC, 2009–2013 average.

¹⁶ Lence SH. 2010. The agricultural sector in Argentina: Major trends and recent developments. In: Lence SH, The shifting patterns of agricultural production and productivity worldwide. (Ch. 14). The Midwest Agribusiness Trade Research and Information Center, Iowa State University, Ames, Iowa.



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