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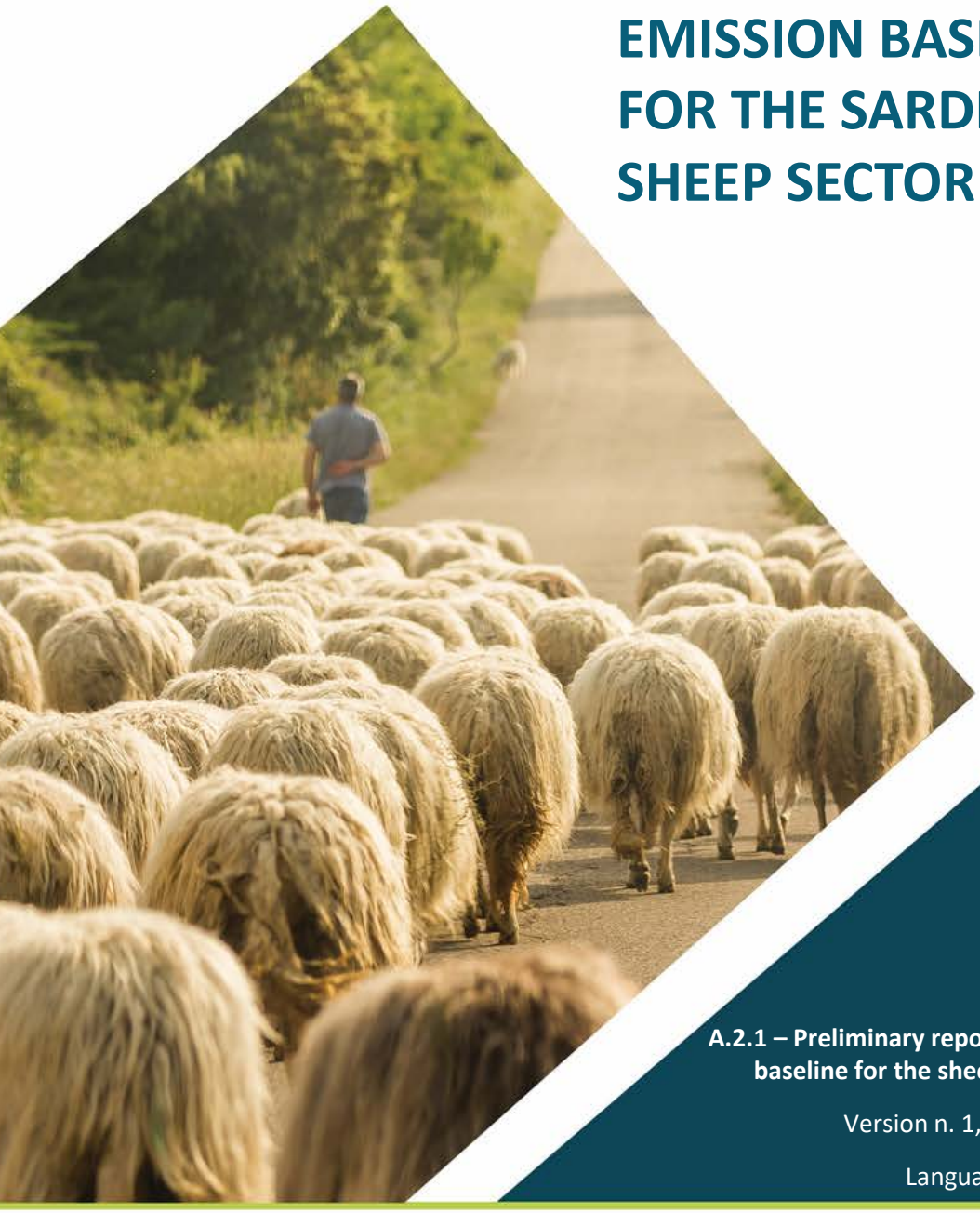
FACING MITIGATION: ESTIMATION OF A GHG EMISSION BASELINE TREND FOR THE SARDINIAN DAIRY SHEEP SECTOR



A.2.1 – Preliminary report of the GHG emissions baseline for the sheep sector in Sardinia

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Executive summary

A GHG emissions baseline for the Sardinian dairy sheep sector was estimated in order to plan effective strategies and furtherly calculate target reduction. It referred to the Sardinia sheep milk production for the 2015 reference year. The cumulative emissions for the reference year resulted equal to 1,565 ktons of CO2 equivalent from the whole dairy sheep supply chain in Sardinia. This value is intended to cover emissions from “cradle to dairy plant gate” system boundaries.

Summary

Introduction

Background

Ruminants GHG emissions are mainly related to methane (CH4) from enteric fermentation, methane from manure management and to nitrous oxide (N2O) from manure management (Opio et al., 2013). Other emission includes N2O from fertilizers and CO2 equivalent emissions from direct and indirect fossil energy consumption. CO2 absorption by plants and CO2 emissions from animal respiration, manure and soils are usually not considered, intending those as accounted for in the short term by the biogenic carbon cycle. Despite their small contribution to global milk and meat output, sheep farming plays a large socio-economic role in some specific economies. In particular, in the Mediterranean region the majority of sheep belong to dairy breeds and Italy plays an important role, being one of the first world sheep milk producers and the top world sheep cheese exporter. On the other hand, sheep significantly contributes to livestock greenhouses gas emissions (GHG) worldwide. In particular emission intensities of sheep products (kg of CO2eq/kg of sheep milk or meat) usually reached much higher values than cow and goat products both for their lower production levels and higher milk solid content. Among Italian regions, dairy sheep supply chain of Sardinia Island contributed to about 44% of heads and 60% of sheep milk production. It is carried out mainly with mixed farming systems and is oriented to the production of 3 types of PDO Pecorino cheese destined to the world trade and national market.

Objective of the report

The emission baseline estimation aimed to:

- define the most effective demonstrative action and the most viable strategies of GHG mitigation at farm and processing plant level;
- plan the future policy regulation of the regional government to get an important reduction of emissions in the next 10 years.

1. Estimation of the emission baseline estimated from literature values

Emission baseline for the Sardinia sheep sector was calculated on published data and coefficients on emission inventories. The baseline calculation was adjusted to consider the Sardinia sheep milk production for the 2015 reference year. Dairy sheep in Sardinia are around 12,000 distributed among a broad variety of production systems for the Mediterranean environment. Sardinian sheep consistency belong almost exclusively to Sarda sheep breed and was estimated based on Italian statistical official records (Istat) Sardinian sheep sector, estimated as average of 10 years, accounted for 3.3 million sheep heads and 3.15 million liters of produced milk.

Animal emissions

Data reported in Atzori et al. (2014; 2013) from Italian inventories and animal emissions were considered. This study was conducted by an estimation of the population profile of Italian sheep population accounting for differences at regional level of: consistency, incidence of milk and/or meat production specialization, morphological and productive characteristics of raised sheep breeds, livestock systems and dietary factors. Emission estimations for enteric methane were based on the use of the methane emission factor (Ym). The energy of emitted CH4 was calculated as function of Metabolizable energy intake (MEI) and was based on NE requirements (Vermorel et al., 2008).

kg of emitted CH4/day per head = MEI (MJ/d) x Ym/55.65

where Ym (MJ) = -0.15 x Digestible energy of the diet % + 21.89.

The Small Ruminant Nutrition System (Tedeschi et al., 2010) was used to estimate DMI, diet DE, NE (lactating, dry, pregnant sheep, rams, replacement and fattening lambs). Emissions from manure management (of CH4 and N2O), detailed per sheep farming system were also include among the animal emissions. Cattle coefficients, varying with manure management systems from IPCC (2006), based on N excreted and air temperature were used. Daily nitrogen excretion of animal categories was estimated based on empirical equations (Decandia et al., 2011) for lactating, dry, pregnant sheep, rams, replacement and fattening lambs. The inventory confirmed the values of Vermorel et al. (2008) regarding enteric emissions of methane per lactating dairy sheep (13.6 kg/y vs. 14.4 kg/y of Vermorel et al. (2008)) (Table 2).

Emission intensity resulted: for dairy sheep, 3.2 kg of CO2eq per kg of fat and protein corrected milk with 6.5% fat. Data from this study, carried out at territorial level were preferred to a meta-analysis carried out on different studies from literature for the baseline estimation trend. The reason of this choice was based on the fact that available in literature focuses specific production and environmental condition and are based on different methodological approaches. These differences make difficult the comparability of results and the estimation of weighted average values for the Sardinian conditions.

Table 1. Population profile and parameters considered for the Sardinian inventory of the regional sheep flock.

Population profile and parameters	% of the flock
Ewes,%	76.5
Rams, %	3.5
Repl. lambs, %	20.8
Lambs exceeding the replacement	
suckling. lambs, %	6.8
fattening lambs , %	-
Reproduction parameters	
Fertility, % of adult ewes	0.88
Prolificacy, % of lambed ewes	1.2
Milk yield, kg/year per ewe	145

Table 2. Animal emission intensities of the Sardinian sheep sector.

	Methane			Nitrous Oxide	CO_2 equivalents		
	Enteric	Manure	Total	Manure	Enteric	Manure	Total
kg/head	1.4	0.8	11.2	0.04	260	31	291
kg/adult sheep	13.6	1.1	14.7	0.05	341	41	382
Incidence					89%	11%	100%

Emissions from Feed. Fertilizers, direct and indirect energy and post farm sources

FAO estimates on the incidence of each emission source on the total LCA of a "from cradle to gradle" approach were considered adequate for this study (Figure 1). The reliability of these coefficients was the fact that FAO LCA was applied to a large range of condition with a territorial (country and continent) scale and accounting for mixed and pasture farming systems. The emissions attributable to produced and purchased feeds, fuels, energy and secondary emissions were estimated equal to 26.9% of total emissions following FAO estimates reported in Figure 1. Processing and post farm emissions were considered equal to 10% of total emissions based on Sardinian site-specific studies (unpublished data). The cumulative emissions from the whole dairy sheep supply chain in Sardinia in the reference year resulted equal to 1535 ktons of CO_2 equivalent that might be attributed for a 80% to milk and 20% to meat. This value is intended to cover emissions from "cradle to dairy plant gate". The distribution of the emissions was reported in Table 3.

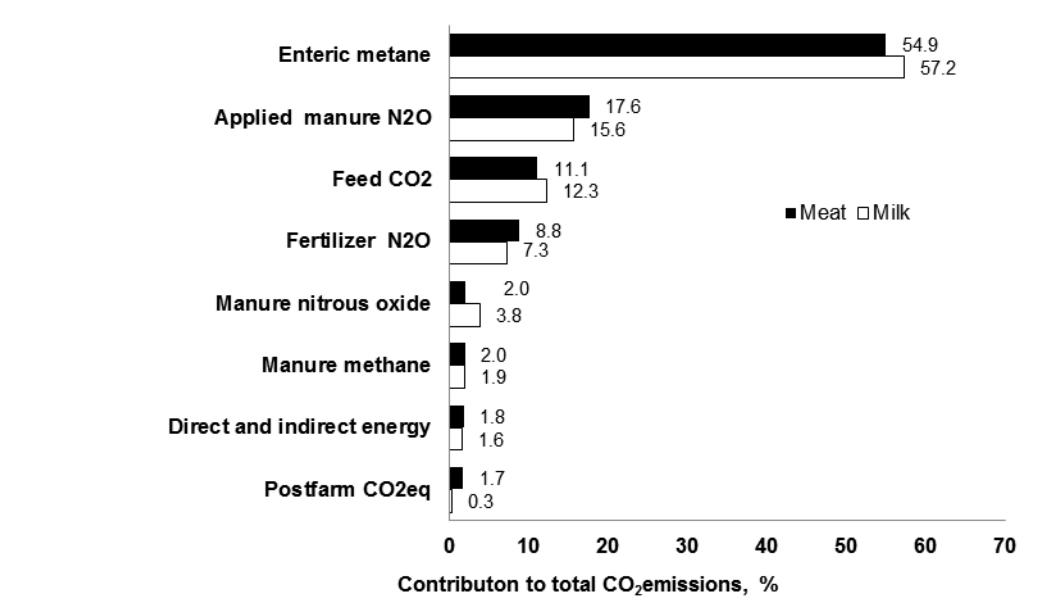

Figure 1. Emission source contribution to small ruminant CO_{2eq} for meat and milk production (adapted from Fig. 14 of Gerber et al., 2013)

Table 3. Emission baseline estimation. Calculation summary for the Sardinian dairy sheep sector.

Item	Used value	UM	source
Sardinia milk production	315,500	million liters	Istat 10 year average.
Sardinian Sheep Heads	3.15	heads	Istat 10 year average.
Emissions per liter	3.2	kg of $CO_{2\,eq}$ /kg 6.5% FCM	Atzori et al., 2014
Emissions LCA			
Animal emissions (enteric and manure sources)	73.10%	% of total	Gerber et al., 2013.
Milk processing	10%	% of total	Specific local studies
CO_2 equivalent emissions			
Animal emissions (enteric, manure)	1,010	kton of kg CO_2	estimated
Other farm emissions (fertilizers, energy, feeds)	1,381	kton of kg CO_2	estimated
Processing	153	kton of kg CO_2	estimated
Total Sardinian Sheep Sector emissions from cradle to dairy plant gate	**1,565**	**kton of kg CO_2**	**estimated**

*sheep milk density was consider equal to 1.033.

2. Estimation of the emission baseline based at territorial scale

The reported activity included the elaboration of a dataset from the regional Farmer Association relatively to farm emissions of the Sardinian Dairy sheep sector. This activity is in progress. A dataset was obtained from the Sardinian Regional Farmer Association (ARAs) reporting detailed information on the regional sheep farms. Data were gathered from the Aras technical staff and included data on about 700 farms and in particular from 200 of them with a deeper level of recoding relatively to the farm records and details. Used data included information animal categories, milk production, crop and pastures size and management, animal facilities information, characteristics of milking plants, energy consumption. The dataset is under analysis and exploration in order to obtain a statistical distribution of the farms relatively to their characteristics for flock size, productive level, manure and crop management energetic consumptions. A specific model based on the Tier 2 approach will be uysed to estimate the farm emissions per functional units. A deeper analysis of this dataset will allow to relate farm inputs and characteristics to the environmental performances of the farms.

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