sheep to ship LIFE

Looking for an eco-sustainable sheep supply chain:
environmental benefits and implications

Sheep Milk *GHG-free*

Best practices for eco-innovation in sheep farming

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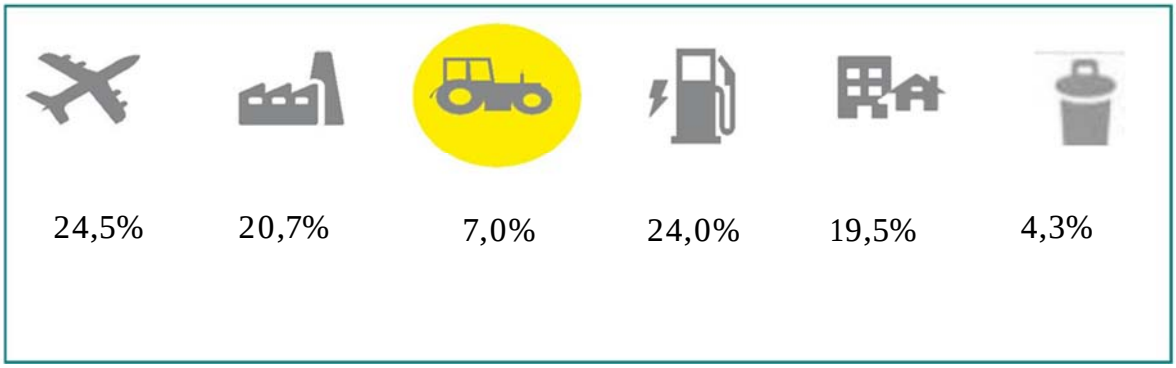
The environmental role of sheep farming

Farmers are the main actors in the complex relationship between agriculture and the environment. For instance, a proper management of pastures contributes to maintaining the biodiversity of flora and fauna. In addition, sheep grazing millions of hectares of permanent pastures and meadows, favour the store of significant amount of carbon in the soil. Moreover, their role as grazers in the prevention of fires and soil erosion is now widely recognized. In contrast, sheep produce large amounts of greenhouse gases (mainly methane) through their digestive system, which is common to all ruminants. Finally, sheep farms consume energy and fossil fuels, related to the production of forage and concentrate.

The SheepToShip LIFE project has identified and field-tested farming techniques that can reduce the impact of sheep systems on climate change while enhancing their environmental role.

The greenhouse effect is a phenomenon due the lower escape of infrared rays from Earth's atmosphere from escaping into space. This is composed by various gases and is beneficial for many reasons: among them because it maintains relatively steady the air temperature on the Earth's surface around an average of 14°C.As human activity increases, this layer thickens and becomes a source of climate imbalance.
Mitigation techniques on sheep farms can reduce Global Warming, increase farm performance, improve animal welfare and product quality.



Main sources in Italy of greenhouse gas emission - (Source: ISPRA 2020)

Which are the greenhouse gases produced in sheep farming?

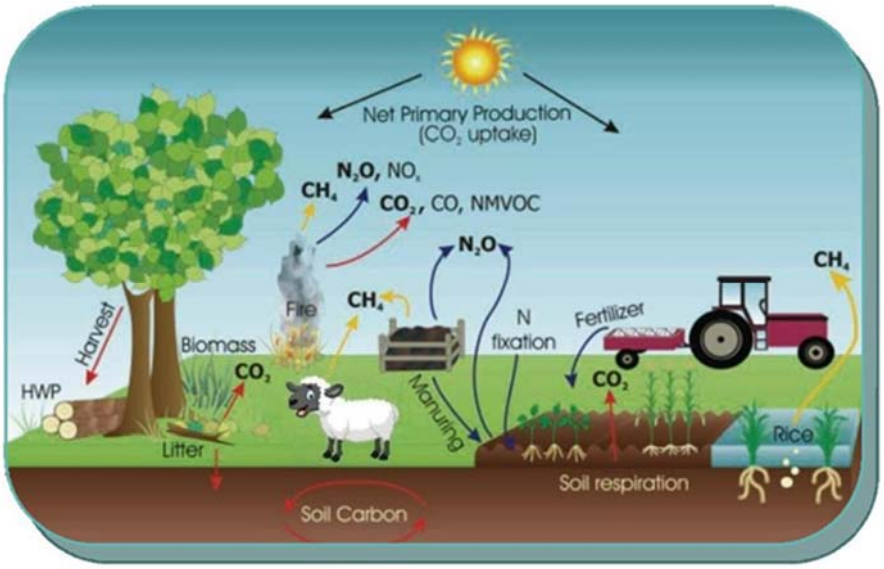
Methane (CH_4), whose emissions come i) from the fermentation of feedstuffs in the rumen (so-called enteric methane); and ii) the fermentation of manure.

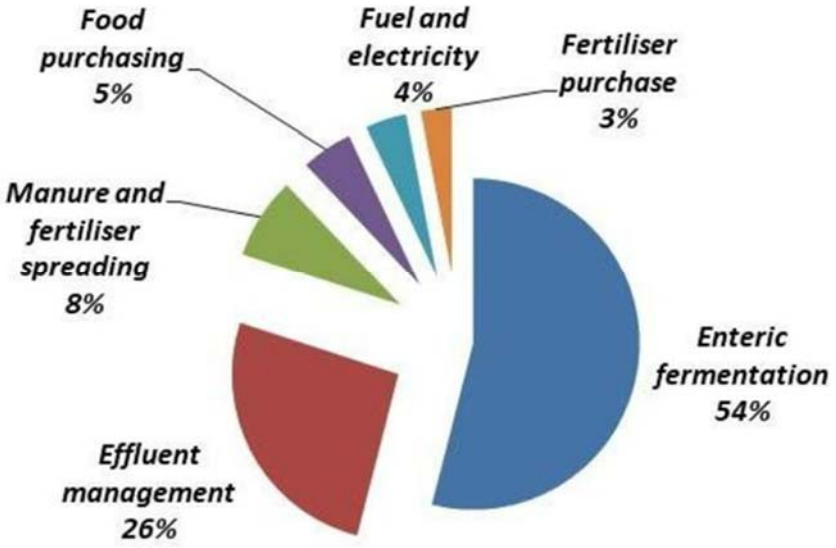
Carbon dioxide (CO_2), which comes from animal and plant respiration and from the use of fuels on the farm.

Greenhouse gases are also emitted during the production and transport of inputs (fuel, electricity, fertilisers and animal feed).

Nitrous oxide (N_20),

is emitted during the storage of manure and the application of nitrogen fertilizers (mineral and organic).





All these emissions are transformed into Carbon Dioxide Equivalent (CO_2 eq) to determine the carbon footprint of sheep milk (kg CO_2 eq/kg fat and protein corrected milk). The two main greenhouse gas sources are enteric methane (closely related to animal feed intake and its composition) and feedstuff on farm production and its purchase.

Which practices limit green house gas emissions and energy consumption?

From the on-farm survey carried out in Sardinia using the Life Cycle Assessment (LCA) the environmental hotspots of the farming systems adopted in Sardinia have been identified and the best mitigation techniques devised.

The emission mitigation techniques developed in SheepToShip LIFE can be attributed to four areas of intervention:

a. Herd management (fewer animals, more productive)

b. Livestock feed production (management of the fodder chain)

c. Cultivation techniques (land use)

d. Energy consumption and choice of technologies

Taken together, these techniques aim to

a. Minimize the environmental impacts of sheep farming

a. Maximize economic and production efficiency

a. C. Optimize the use of land resources

Improving the reproductive efficiency of diagnosed flock

There is a great proportion of non-productive animals (25-30%) in the sheep flocks (replacement animals, and non-parturient). As they do not produce milk, their contribution to carbon emission increases abruptly emission intensity of the farm (kg CO_2 eq/kg milk).

So the greater is the number of non productive animals on a farm, the higher is the emission of CO2 eq into the atmosphere.

The activity follows the so-called "Sementusa" protocol. The action involves increasing the reproductive efficiency through veterinary inspection of the flock and early identification of the of infertile animals by ultrasound scanning and the identification/cure of underlying health or management problems by general and clinical inspections and analysis of blood and fecal samples

This protocol is easily put in place from a technical point of view following a training period for the farmer, both to implement the system and to manage and interpret the collected data.

Action –Objective

Increase fertility and increased milk and meat production with lambings in the optimal period

Weakneasses

Low fertility of ewe lambs due to abortions

Increasing ewes milk' productivity

An individual milk recording of all ewes in a farm can help the management andearly culling of low-productive ewes.

This objective can be achieved by:

the recording service of regional breeders association (AARS) based on ICAR approved milk jars;

use of milkmeters;

The milk recording is the basis of genetic progress and showsfurther positive effects .

For instance, the recording at mid-lactation phase makes it possible to feed more adequately the sheep if they are divided into two groups of different milk yield. This can allow also to anticipate the matings of the less productive ewes. Moreover, it allows an accurate early culling of very low-producing ewes.

The main results expected by these techniques are:

a better feeding efficiency by dividing the flock into groups at different production levels

the reduction of the permanence of less productive animals on the farm with anearly culling and consequent reduction in production costs and emission intensity.

Action –Objective

Implementation of milk recording

Weakneasses

Low milk yield and feed efficiency

Increasing of diet digestibility in sheep feeding

This is due to an early decay of forage quality in spring, because of its fast turning to reproductive phase and the difficulty to prevent it by an early cut of hay

Feedblocks based on molasses and palm oil and mineral-vitamin were made available with a ratio of 1 block 25-30 sheep during summer.

Sheep were either grazing stubbles or fed grass hay ad libitum.

Expected results were
1. Increase of diet digestibility
2. as a consequence: better energy and protein balance

A modeling exercise has been run in order to estimate the impact of using the feeding blocks considering the two levels of response:

A) increase of diet OM digestibility by 2 units
B) Increase of diet OM digestibility by 4 units

Weaknesses

Low digestibility of diet of sheep grazing on stubble and fed with poor quality hays during pregnancy

Action objective

Better efficiency of feed se as experimentally verified in pregnant Sardinian sheep

Increasing feed self-sufficiency by natural and restored pastures

Revision of annual cultivation plan, with the replacement of part of the area usually devoted to annual crops with improved perennial pastures, consisting of mixtures of perennial and self-seeding leguminous and graminaceous species.

Persistent pasture management involves rotational grazing and -3 flail mowing to control weeds after grazing. Grazing season stops at flowering to favour re-seeding, which is fundamental especially the first year.

The expected results of these actions are:

1. Reduction of fodder self-production costs and reduction of the use of energy inputs, (fuel, oil,seeds and fertilizer)
2. Reduction of working costs and working times necessary for fodder production
3. Reduction of GHG emissions due to less use of energy inputs
4. Reduction of soil erosion due to the lower intensity of the work involved

Action–Objective

Reduction of the economic and organizational burdens of intensive soil use.

Weakneasses

High percentage of cultivated land with annual forage crops that determines high working costs and high diesel consumption

Increasing of feed self-sufficiency by replacement of forage crops with a short lived perennial legumes

Action-Objective

Recution of work and organizationl costs deriving from the frequent soil tillage for forage production: reduction of GHG emissions, improvement of the quality of fodder biomass and increasing of the mik yield per lactating ewe

Weaknesses

High intensity of land cultuvation. It consecutes a high level of fuel consumption and hard workloads

Revision of the cropping plan, with the replacement of a part of the area invested in annual grass with a biennial forage (sulla). In detail, the soil is tilled; the seed is inoculated and then sown. Crop management involves rotational grazing associated with flail mowing (1 to 2 operations per year) with the aim of controlling weeds. The results of the action are below listed:

Reduction of the use of energy inputs, such as fuel, oil, seeds and fertilizer usually used in the establishment and management of annual forage crops;

1. Reduction of workloads and work times necessary for fodder production, with relative improvement of the organization and planning of farm activities in the autumn;
2. Improvement of the quality of the self-produced forage biomass and of the milk yields per lactating ewe;
3. 4. Reduction of GHG emissions due to less use of energy inputs.
4. 5. Reduction of soil erosion due to the lower intensity of the work involved
5. 6. Improvement of soil fertility with an increase in the stock of organic C.

Improvement of conserved forage digestibility

Use of innovative haymaking techniques to produce early cut hay and wrapped (and chopped) bale silage. These techniques are realized anticipating the temporal windows of forage cutting to the optimal phenological stage and reducing the temporal windows of haymaking (2 days) to preserve forage from adverse weather condition that can occur during traditional haymaking (6-7 days).

As a result of adopting this technique, and feeding the obtained hay an improvement production and environmental performance has been achieved:

a) more milk,

b) less enteric CH_4 per kg of FPCM

c) Lower amount of off-farm feeds, especially those rich in protein such as alfalfa and soybean meal and thus the emissions linked to them (GHG emissions from off-farm produced feeds).

Our results showed that high quality forages can be produced and used effectively to totally replace by-products and purchased forages (alfalfa hay) and partially (62%) concentrate rich-proteins

Action –Objective

Increase the digestibility of on farm produced forages and especially the quality of forage

Weakneasses

On farm low quality forages

Conservative cultivation of forages and cereals

Partial replacement of conventional tillage (ploughing, harrowing, sowing with

spreader and seed covering) with minimum tillage carried out using a combined machine, consisting of a grubber, crusher discs and toothed roller. Subsequently, it was carried out the on-row sowing.

1) the reduction of energy input such as diesel and oil consumption, amount of seeds used for sowing and machinery consumption;

2) the reduction of work costs and working time needed to carry out the annual soil tillage and cultivation practices;

3) the reduction of greenhouse gases emission due to the decrease of energy input utilization;

4) the improvement of the soil fertility thanks to the reduction of soil organic matter mineralization.

Action –Objective

Reduction of soil tillage intensity with the aim to reduce the cost of crop implantation, the GHG emission and the loss of soil organic matter.

Weakneasses

High soil tillage intensity and fuel consuption due to the conventional tillage used for crop implantation .

Sustainability in electric energy power

The purpose of this operation is to increase operational efficiency while reducing energy consumption. The role of the inverter is to modulate the electric engine that drives the milking pump, in order to vary its rotation speed in relation to the vacuum level that is really necessary in the different phases of the milking routine.

The inverter varies the frequency of the alternating current that feeds the motor so that it only delivers the power really needed to maintain the vacuum reserve. In addition to the reduction

in electricity consumption, the associated advantages consist of a reduction in milking plant wear and tear (with a consequent increase in duration and maintenance intervals) and lower noise levels for the benefit of human and animal well-being.

Weakneasses

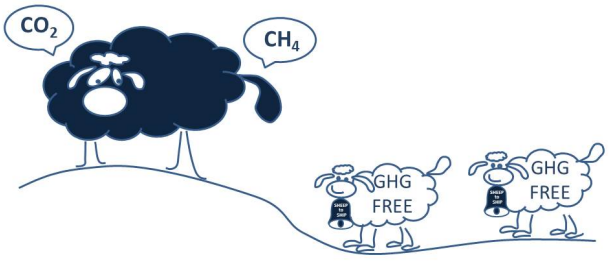
High energy consumption for electrical power used in the farm

Action –Objective

Improvement of energy performance to reduce milking electricity consumption.

Results of mitigation techniques

Groups of mitigation techniques	Intensity of emissions change (kg CO_2 eq)	Gross margin change (€)
A) Animal management (breeding protocols, and innovative management)	**- 3 ÷ - 27 %**	**+1 ÷ +120 %**
B) Feed production and reduction pf purchased con concentrates (increase in on-farm	**- 3 ÷ - 9 %**	**- 1 ÷ + 28%**
C) Forage crop management (low input farming practices, use of legume mixtures and self healing grasses)	**- 3 ÷ - 7 %**	**+1 ÷ - 8 %**
D) Energy consumption (reduction of crop operations, use of renewable energy)	**- 0.5 ÷ - 5 %**	**+1 ÷ +2 %**



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