Energy savings in dairy systems

Energy requirements on dairy farms are significant, and electricity consumption is concentrated in three main areas:

MILKING – CLEANING – COOLING

Various solutions are available on dairy farms, enabling a reduction of up to 50 per cent in the energy consumption associated with these three areas

Below you will find the technical data sheets produced by the 'Energy Management' group of the Interreg Upper Rhine ResKuh project

GENERAL SAVING

PRE-COOLER

HEAT RECOVERY UNIT

OVER-INSULATION OF WATER TANKS

OTHER SOLUTIONS AT THE DAIRY FARMS

HOUSING

FUEL

You can find other ResKuh technical fact sheets on energy or other project topics on our website: https://agroecologie-rhin.eu/en/reskuh-en/downloads

Energy consumption on dairy cow farms
Electricity and fuels

Consumption references
Quintiles and médian

Electricity

		low consumption				high consumptions
kWh/1000 l	Dairy cows - no milking robot	< 45	45 à 54	54 - 59 - 65	65 à 83	> 83
	Dairy cows - milking robot	< 55	55 à 67	67 - 73 - 80	80 à 98	> 98

Fuel Consumption

		low consumption				high consumptions
l/1000 l	Dairy Cows	< 17	17 à 21	21 - 22 - 24	24 à 28	> 28

The median consumption of a dairy cow farm is 59 to 73 kWh/1000 liter of milk, depending on the milking system, and 22 liter of fuel/1000 liter of milk produced.

Farms with robotic milking consume slightly more, but the differences can be very large depending on the technology of the robot, with newer robots consuming less.

And there are significant differences :

Energy-efficient farms consume half as much energy per litre of milk as energy-intensive farms.

Point of attention :

These consumption references are for the dairy unit and do not include specific consumption linked to barn drying, grain drying, irrigation or the dairy processing unit.

For more information and a breakdown of consumption by production system - in French :

Consommation d'énergie en élevage herbivores – Idele, 2024. Lien

This study was carried out with the support of the CNE.

Electricity consumption in dairy farms

Main consumption categories

The dairy represents around 45 kWh/1000 litres of milk, including milking, cooling the milk and cleaning the milking installations.

1. Cleaning - water heater **:**

18 kWh/1000 l ok milk

2. Cooling - tank :

17 kWh/1000 l ok milk

3. Milking – vacuum pump

10 kWh/1000 l of milk

These three items account for up to 60 to 75% of the consumption of livestock farms.

Other sources of consumption

The remaining 25 to 40% of electricity is used for lighting, scraping, slurry stirring, grain mills, automatic concentrate distributors, robots (for feeding, forage or slurry), electric fences, etc.

Reducing consumption at the dairy farm
Installation of a heat recovery unit

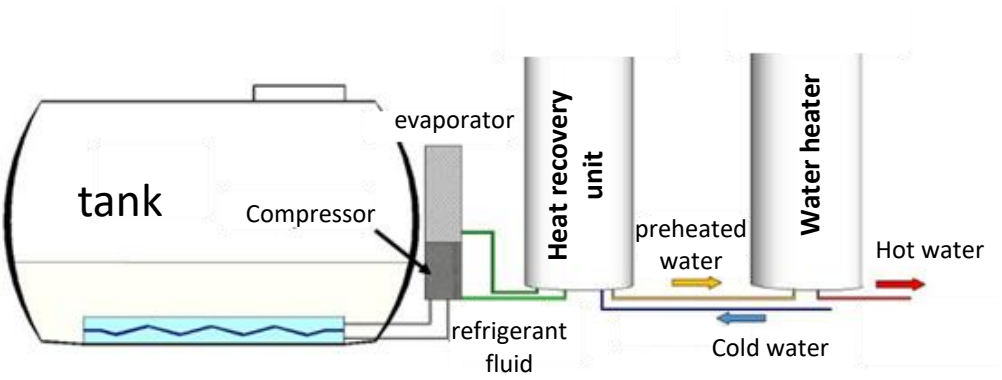
Reminder of electricity consumption

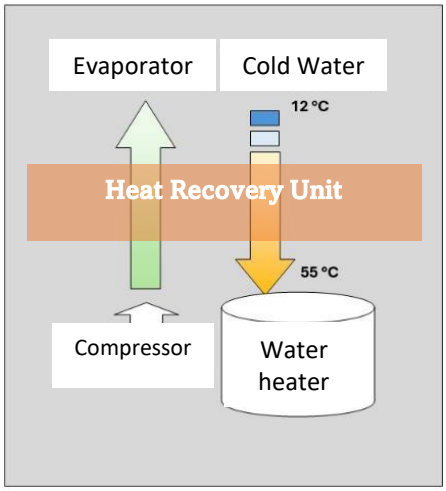
59 to 73 kWh / 1000 liter produced milk, including 18 kWh for water heating

The water heater can account for 25 to 31% of the dairy farm's consumption.

The heat recovery unit

The heat recovery unit recovers the energy released by cooling the milk to preheat the water in the water heater.





40% reduction in tank energy consumption

Schematic diagram of heat recovery unit on chiller(diagram for internal heat recovery unit)

Reducing consumption at the dairy farm
Installation of a heat recovery unit

Internal or plate recuperator

There are two heat recovery technologies

Internal recuperator

The recovery tank incorporates a recuperator through which the refrigerant circulates;

Une température jusqu'à près de 60°C dans le ballon

Plate recuperator

A plate system is installed in the tank in which the refrigerant and water for the water heater circulate. This system is more sensitive to clogging and hard water.

In both cases, back-up is provided by a second electric storage tank connected in series, or by a storage tank with electric back-up.

Possible to couple heat recovery and pre-cooler

Installing a pre-cooler limits the heat to be recovered from the tank.

Above 600,000 litres, pre-coolers and heat recovery units can be combined without any problem. For farms with lower production levels, profitability will take longer to achieve.

Sources and further information – in French :

Réduire la consommation électrique du chauffe-eau grâce au récupérateur de chaleur
https://www.gie-elevages-bretagne.fr/admin/upload/PLAQUETTE_GIE_Recuperateur_de_chaleur_2013.pdf

Consommations énergétiques liées à la traite

Reducing consumption at the dairy farm
installation of a pre-cooler

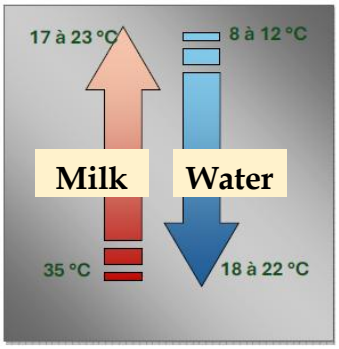
Reminder of electricity consumption

59 to 73 kWh / 1000 liter produced milk, including 18 kWh for water heating

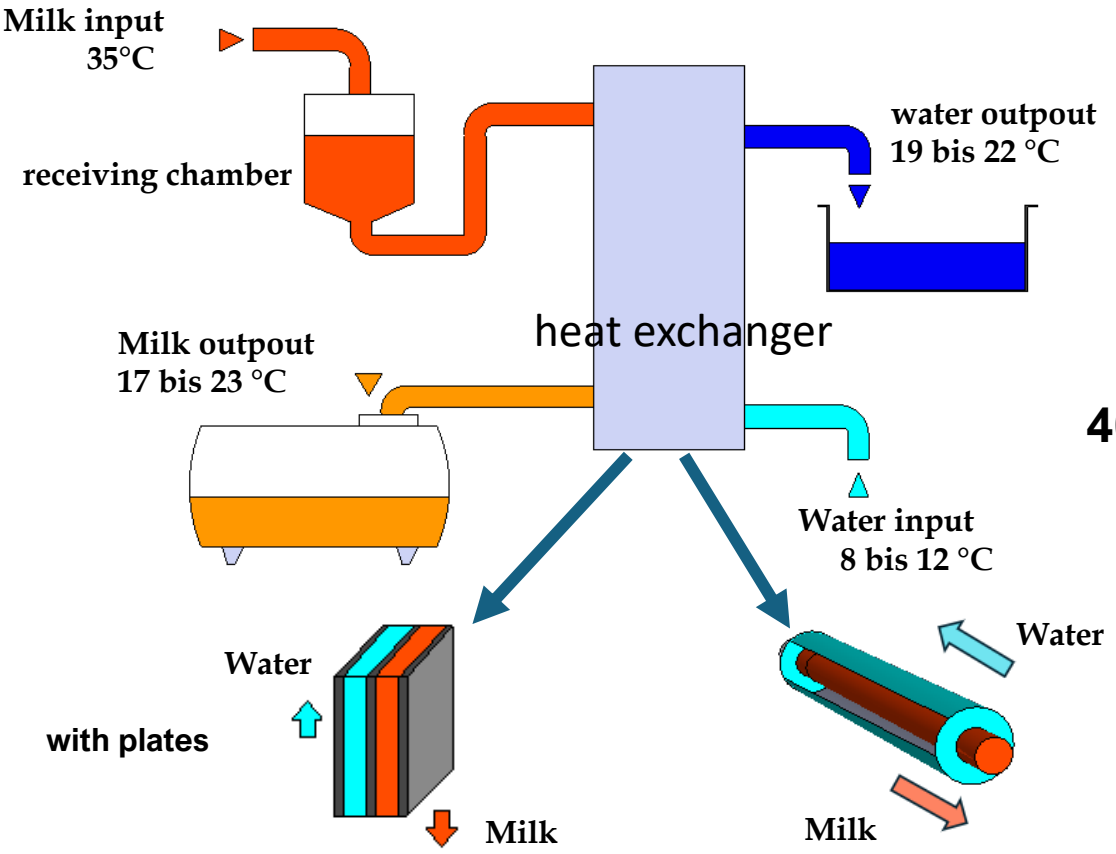
The milk tank can represent for 23 à 29 % of the dairy farm's consumption.

The pre -cooler

The pre-cooler partially cools the milk by bringing it into contact with cold water through a stainless steel heat exchanger.



Schematic diagram of the precooler principle



Pre-cooler installation diagram

40% reduction in tank energy consumption

Reducing consumption at the dairy farm
installation of a pre-cooler

Tubular or with plates

Two pre-cooler technologies are available

Tubular

They are relatively bulky, but generate little pressure loss on the milk pump and are not very clogged.

With plates

They take up very little space but cause high pressure losses in the milk pump.pump. They can become very clogged and some farmers have had to remove them.

Adapt the dimensions to the size of the milking parlour :
The surface area/length of the exchanger depends on the volume of milk arriving at the same time. Larger parlours need larger equipment, while **robotic milking systems need smaller, less expensive equipment.**

Warm water to be used

Cooling the milk requires 1.5 to 2 litres of water per litre of milk, or 30 to 50 litres per cow per day, which is less than the cows need to drink.

This lukewarm water can also be used to water cows, and some farmers have reported an increase in milk production of 1l/day.

Sources and further information – in French :

Réduire la consommation électrique du tank grâce au pré-refroidissement **du lait**
https://www.gie-elevages-bretagne.fr/admin/upload/Plaquette_pr__refroidisseur.pdf

Consommations énergétiques liées à la traite

Reducing consumption at the dairy farm
Over-insulation of hot water tanks

Hot water cylinders all have a layer of insulation in their structure, but this layer is very thin, often 2 to 3 cm.

This thin layer of insulation leads to heat loss, which could be limited by additional insulation of these hot water tanks.

Is additional insulation feasible? And what are the results?

Illustration of the savings achieved in a cheese Farm.

water heater
Le Pradel

Energy saving :

Energy savings are calculated by comparing consumption before and after insulation.

- Electricity consumption before over-insulation: average of 5.15 kWh/d
- Electricity consumption after over-insulation: average of 3.72 kWh/d

⇨ **28% reduction in energy consumption per day**

⇨ **Potential savings of 1.43 kWh/day or 522 kWh/year.**

In addition, the cheese production that was the subject of the test was shut down and did not operate for 2 weeks in June, making it possible to calculate the consumption of the water heater to maintain the temperature of the storage tank.

Consumption measured without the use of hot water and before insulation is 3.34 kWh/d.

⇨ 43% reduction in the energy required to conserve heat

Savings over 365 days: 522 kWh x €20 c/kWh = €105 excluding VAT

In addition: insulate your hot water pipes!
The measurements carried out do not allow significant savings to be calculated, as water consumption practices are also changing. But the cost of installation and the ease with which it can be carried out should be an incentive to do so. Insulated pipes will also avoid contributing to high room temperatures in summer.

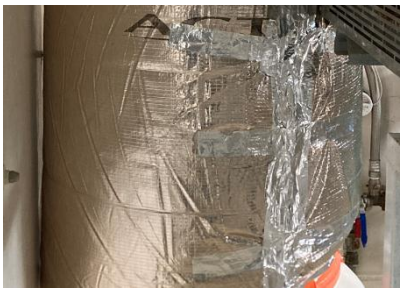
Reducing consumption at the dairy farm
Over-insulation of hot water tanks

Installation of the insulation

Installing the insulation involved unrolling 12 cm thick flexible insulation around the 300-litre tank, which has the advantage of being watertight. An additional section was laid on top of the tank.

The insulation was held in place by applying double-sided tape to the tank, and metallised tape was applied to seal everything.

The insulation was fitted leaving the lower part of the tank, which is on the floor, bare to limit problems with water when washing; and leaving the electrical part accessible to avoid any condensation in this part that could cause the water heater to burn out.



Cost and implementation time

Two people are needed to hold and install the insulation, and it takes 2 hours for 2 people to complete the installation.

➔ 110 € excluding VAT and 4 hours' labour for installation.

These results come from the URE 2030 program, conducted in France with the support of Ademe.
The experiment was conducted at the Pradel farm.

Reducing consumption at the dairy farm
Ventilation and cleaning of condensers

Energy consumption on dairy farms is concentrated on milking, cooling and cleaning, which account for almost 80% of electricity consumption.

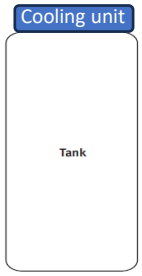
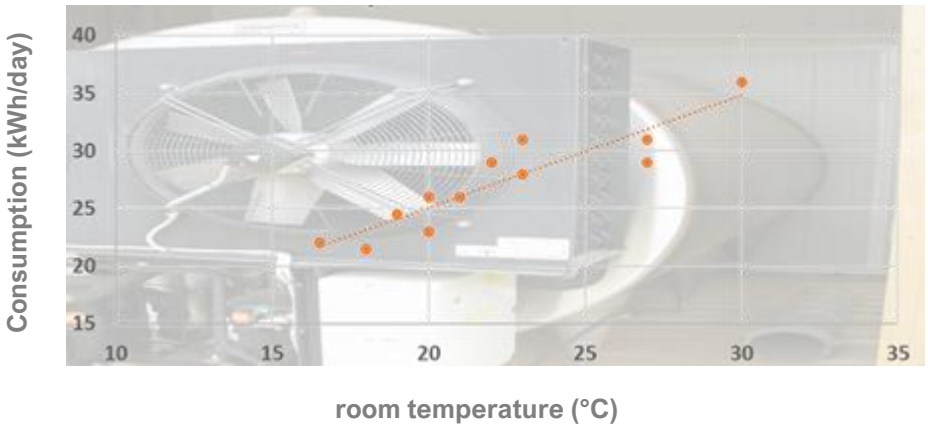


diagram of a tank

To cool the milk in the tank, it is necessary to facilitate exchanges between the tank condenser and the ambient air.

development of tank consumption as a function of room temperature



The graph opposite shows the increase in tank consumption as the temperature in the room rises.

Cleaning the condenser :

Heat exchange at the condenser can be limited by dust deposits, which act as insulators and restrict heat exchange.

Blow out the condensers at the compressor, holding the jet 20cm away, and ask your installer to clean them with a brush or lukewarm water.

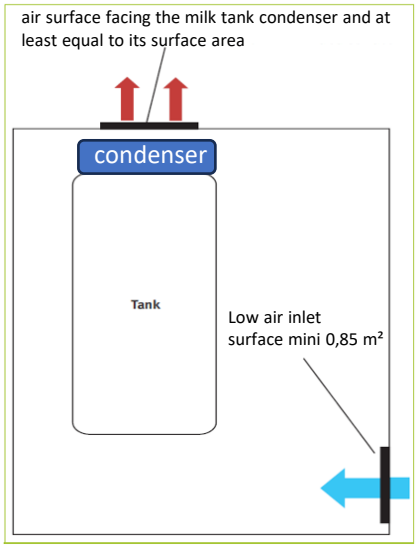
Up to 25% reduction in tank consumption.

Cleaning a clogged unit can reduce tank consumption by up to 25%.

Reducing consumption at the dairy farm
Ventilation and cleaning of condensers

Ventilation - Several solutions

As tank consumption increases with rising temperatures around the condenser, it is important to **facilitate the removal of the heat released.**



Installation of an opening in the wall behind the condenser

In this case, you need an opening opposite the condenser at least equal to the surface area of the condenser and a low air intake of at least 0.85m² on another wall.

Installing part of the tank outdoors

It is also possible to install the part of the tank with the condenser at the rear of the dairy, on a concrete slab, and under a well-ventilated closed shelter.

Installation of the refrigeration unit outside (for tanks with separate refrigeration unit)

This installation must be carried out, as in the case of a part of the tank outside, on a concrete surface that is sheltered, ventilated and in a low-dust area.

Up to 20% savings on tank consumption.

Cooling unit ventilation can reduce tank consumption by up to 20%.

What is the link with pre-coolers and heat recovery units?

As the pre-cooler limits the need to cool the tank, and the recuperator recovers the heat to heat water, these solutions will offer lower gains.

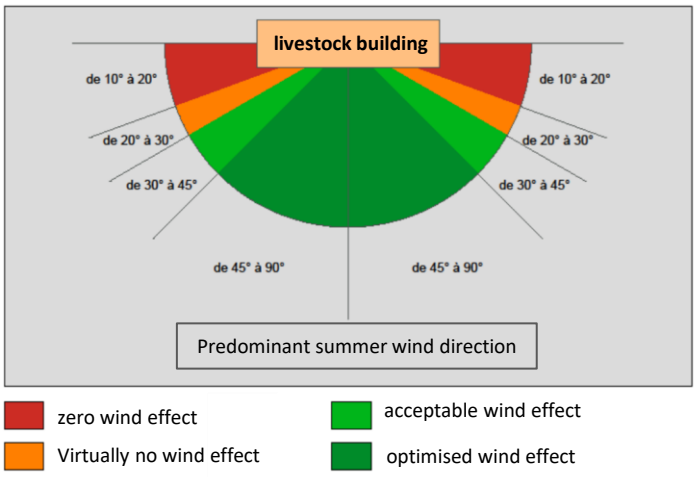
Source of graphics and photos : Les consommations d'énergie en bâtiment d'élevage laitier

Designing livestock buildings that minimise the effects of heat stress :

- Improving natural ventilation
- reduce heat radiation
- Cooling the building

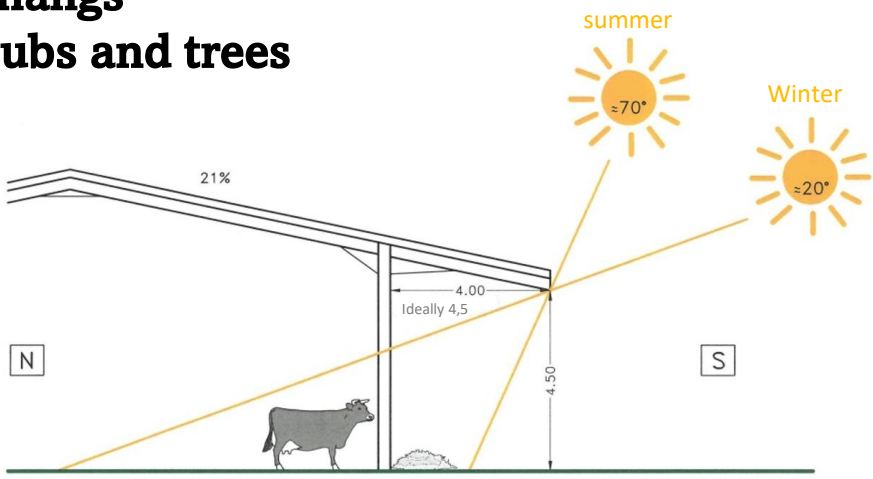
Improving natural ventilation :

. ensure a permanent unobstructed air inlet at the top, and protect it (roof overhang)
. incorporate roof offsets and ventilation vents
. limit the use of fixed cladding
. to catch the prevailing wind or winds during hot weather by opening as low as possible
. Ensure there is sufficient space between buildings and avoid adding outbuildings (nursery, silo, etc.)



Reducing direct and indirect sunlight: making a parasol

. For roofing: limit the use of translucent panels; relocate them to facades shielded from solar radiation.
. insulate the roof
. for facades: limit the use of sheet metal and concrete
. provide shade for animals and fodder using awnings and roof overhangs
. incorporate vegetation: shrubs and trees



Cooling the building:

. install a suitably sized mechanical ventilation system
. install a mechanical ventilation system and a shower

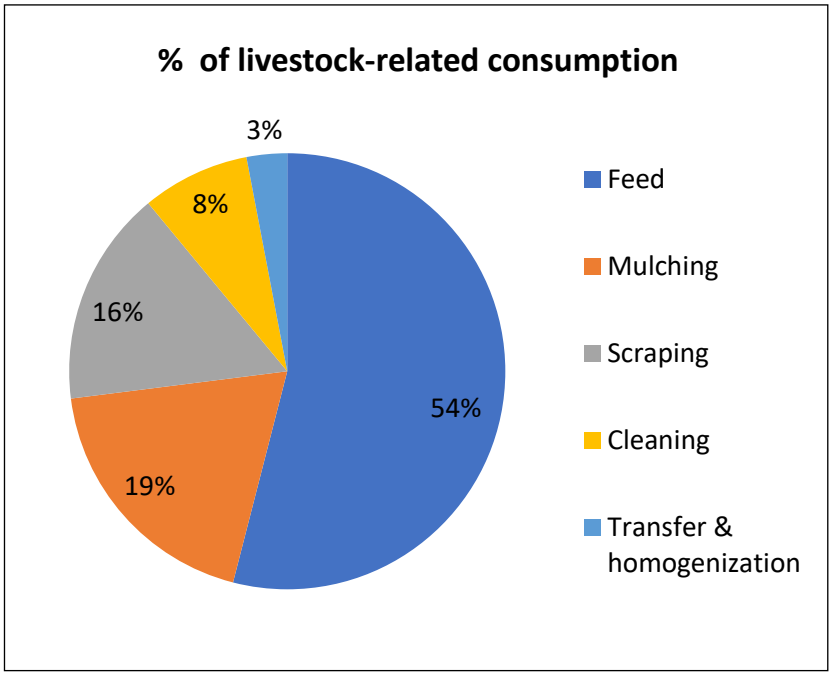
Photo credits: Chambre d'Agriculture d'Alsace

All CNIEL work on the same subject can be found at https://cniel-infos.com

Lower fuel consumption

In dairy farming, fuel consumption depends on the use of the tractor for various operations linked to farming practices.

Fuel oil consumption items



Source: Energy consumption in dairy barns, benchmarks for consumption and ways to save. Institut de l'élevage 2009.

On average, **45 l of fuel oil/dairy cow/year** are used in buildings per farm, but this quantity varies greatly depending on the system.

Grassland systems are the most economical in terms of fuel consumption, due to the short time the animals spend in the barn.

Energy consumption also varies according to the **type of manure used**. A manure system requiring scraping, mulching and cleaning will consume more fuel (54 l/dairy cow/year) than a slurry system (37 l/dairy cow/year).

Traction power and **operating time** also have an impact on fuel consumption.

Fuel oil or electricity?

Generally speaking, for an operation that can be carried out with fuel oil or electricity, electricity is the least energy-intensive solution:

- Use of a **hay claw** (18 kWh/dairy cow) rather than a tractor (304 kWh/dairy cow) for forage distribution.
- Use of a **mechanized scraper** (28 kWh/dairy cow) rather than a tractor (91 kWh/dairy cow) to scrape manure.

However, there is no difference in energy consumption between using electric equipment (23 kWh/dairy cow) or a tractor (22 kWh/dairy cow) to homogenize and transfer liquid manure.

Reduce tractor fuel consumption

✓ Optimization of working circuits

- The aim is to **limit the number of tractor movements** and reduce the distance between the silos and the feed table. Smoother traffic flow to the tractor's various workstations also helps to reduce running times and hence fuel consumption.

✓ Optimized driving

- Adopting **economical driving practices** can reduce fuel consumption by between 10 and 15 %. A number of organizations offer training courses in eco-driving.

✓ Tractor operation

- It is possible to have the **performance of a tractor's engine** assessed by various organizations. These test the engine's actual performance against the manufacturer's specifications, and can adjust it to optimize its operation and thus reduce fuel consumption.

ECONOMICAL DRIVING + GOOD ENGINE TUNING
=
approximately **1.5 L of fuel saved per hour**

✓ Controlling the time animals spend in the barn

- Less **time spent in the barn** reduces the amount of work involved in feeding and manure management, and therefore fuel consumption by the tractor.

✓ Automated scraping

- **Automated manure scraping** with a chain or hydraulic scraper in a loose housing barn can save up to 80% energy compared to using a tractor. This saving is due to the power required for effective scraping between the two systems.

✓ Feed distribution

- Tractor operating time depends on how feed is distributed to the animals. With **self-service feeders**, tractor time is 30 % lower than with trough feeders.

Source: Energy consumption in dairy barns, benchmarks for consumption and ways to save. Institut de l'élevage 2009.