



## Azienda Agricola Fontanabona: Green Manure Cultivation

### Farm Description

The Fontanabona farm is located in the Po' Valley, a few kilometers from Verona and the Pre-Alps. It is about 7 hectares large. The Fontanabona family has been cultivating organically since 1982, but the field has the current characteristics since 1999. About 4 hectares of the land is reserved for kiwi crops (under anti-hail nets), while in the remaining part of the land horticultural products (such as lettuce, celery, cabbage, and chard) are cultivated in a greenhouse.

### Farmer Statement

*"I want to be involved in SOLMACC project because I want to share knowledge and best practices at European level."*

### Nutrient Management

Paolo Fontanabona started **composting the farmyard manure** (around 200 t) from a nearby farm together with his **mushroom bed and other on-farm residues**. He spreads the material twice per year on all of his cultures.

● **CO<sub>2</sub>-eq. Reduction: - 49 %**

Composting farmyard manure and mushroom bed residues help to reduce CH<sub>4</sub> and N<sub>2</sub>O emissions, compared to the emissions of a manure pile.

**Climate Change Adaptation Benefit:** ☒☒

**Co-benefits of Compost:**

- Reduces the number of viable seeds in the fertilizer as well as soil erosion.
- A stabilized organic matter.

**Economic Viability:** €€€

The farmer's experience shows that spreading the compost increased his crop yields. At the same time, operational/input and labor costs did not change or even decreased.

In begin of July, the green manure (Sudanese sorghum, *Crotalaria juncea* and *Vigna unguiculata*) in the greenhouse is cut and chopped. It is left and dried and afterwards slightly buried in the soil. Afterwards, the soil is prepared for transplanting the seedlings in the greenhouse. By this, the soil fertility could be improved and the farmer could increase his crop yields.

### Crop Rotation Management

Paolo Fontanabona **introduced legume cultivation** on his 3 ha large **greenhouse areas**. He included cowpeas and sorghum on half of the area. Additionally, on his 4 ha kiwi orchards, he **substituted grassland by permanent green manure**, consisting of crimson clover, vetch, white mustard, rye and oats

● **CO<sub>2</sub>-eq. Reduction: - 50 %**

Legume crops contribute to N fixation and therefore, reduce the amount of fertilizers needed in the following years.

**Climate Change Adaptation Benefit:** ☒☒

**Co-benefits of Legumes:**

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

**Economic Viability:** €

The farmer's experience shows that with the changes in his crop rotation management, yields increased largely. At the same time, all other associated costs (operational/input and labor) increased.



### Tillage Management

Paolo Fontanabona **reduced the depth of tillage** from 20-25 cm to 15-20 cm for all his crops. Weed management is done with **plastic mulch that is used for two years and then professionally recycled.**

● **CO<sub>2</sub>-eq. Reduction: - 13 %**

Reducing the depth of tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Reduced Tillage:

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

**Economic Viability:** €€€

The farmer's experience shows that crop yields were maintained and at the same time input/operational and labor costs were reduced.

### Agroforestry

Paolo Fontanabona **planted 0.21 ha boundary hedges.** Additionally, 4.30 ha of **orchards for fruit production** was established on the farm.

● **CO<sub>2</sub>-eq. Reduction: Around 4.5-35.4 t C/ha are sequestered annually in the soil, tree biomass and hedge biomass.**

Trees and hedges help to sequester atmospheric carbon into plant biomass and soils. Therefore, they function as a carbon sink.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Woody Elements:

- Living habitat for diverse animals (biodiversity protection).
- Alternative income source for the farmer.

**Economic Viability:** €€€

The farmer's experience shows that crop yields were maintained, while input/operational and labor costs did not change with the practice.

### Using green manure and compost for improving soil fertility

To protect soil fertility on the farm, Paolo Fontanabona established a compost production from on-farm residues. He mixes farmyard manure, green manure, and residues from mushroom production. The manure is composted in three trapezoidal piles 1.50 m high and 30 m long, covered by a polypropylene sheet. Additionally, the farmer uses biodynamic preparations. To avoid anaerobic conditions, the farmer turns the composts regularly. Further, he ensures that coarse materials (such as straw) are present adequately. The high humus yield of manure and compost, the quantities with which they are used and the summer green manure grass, close the annual humic balance with a good profit, producing a progressive increase in the humus reserves of the soil. An excellent contribution to the microbial biodiversity of the soil is also potentially made by green manure. The use of mulching instead of working the soil to control weeds reduces oxidation - and therefore losses - of organic matter.





## Azienda Agricola Caramadre: Sudanese Sorghum Grass in the Rotation

### Farm Description

The Caramadre farm is located in the Agro Romano, within the National Reserve of the Coast and near the Macchia Grande Reserve of the **WWF** Natural Oasis. It includes two different areas: one located in Maccaresse (7.5 hectares wide including 2 hectares of cold greenhouses) with mainly fruit production and another area in Torre in Pietra (13 hectares wide). Here, organic crops of several fruits and vegetables (such as broccoli, cabbage, cauliflower, cabbage, summer melons, strawberries, salads, beets, etc.) are planted.

### Farmer Statement

*"Thanks to the SOLMACC practices, I will play a role in the fight against climate change!"*

### Nutrient Management

Before the SOLMACC project, the farmer did not use organic fertilizers. Therefore, a co-operation between a livestock holder and his farm was planned. However, all farms were too far away to justify transport and timing for the farmer. Therefore, now the farmer uses his green manure to optimize his nutrient management.

### Crop Rotation Management

The farmer **introduced legumes into the crop rotation**. They included green manure, broad bean or field beans. In the greenhouse, crotalaria was introduced as a green manure legume. Together, leguminous crops constitute between 20-30% of the crop rotation.

● **CO<sub>2</sub>-eq. Reduction: -+17%, as more external fertilizer was used**

Legume crops contribute to N fixation

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Legumes:

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

**Economic Viability:** €€€

The farmer's experience shows that with the changes in his crop rotation management, yields and all associated costs did not change.



### Tillage Management

Before the project, the farmer plowed all of his crop cultures. Now, he **reduced the depth of tillage** for all crops, by only working superficial (with a depth up to 10 cm).

**● CO<sub>2</sub>-eq. Reduction: -0.5 %**

Reducing the depth of tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒☒

**Co-benefits of Reduced Tillage:**

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

**Economic Viability:** €€€

The farmer's experience shows that crop yields increased and at the same time input/operational and labor costs were maintained.

### Agroforestry

The agricultural areas are surrounded by tree strips of pines and eucalyptus (around 0.08 ha). Their primary function is to protect the agricultural areas against the wind.

**● CO<sub>2</sub>-eq. Reduction: Around 64-488 kg C/ha are sequestered annually in the soil, and tree biomass.**

Trees and hedges help to sequester atmospheric carbon into plant biomass and soils. Therefore, they function as a carbon sink.

**Climate Change Adaptation Benefit:** ☒☒

**Co-benefits of Woody Elements:**

- Living habitat for diverse animals (biodiversity protection).
- Wind protection.
- Eucalyptus woods chips are used for weed suppression in arable fields.

**Economic Viability:** €€€

The farmer's experience shows that crop yields were maintained, while input/operational and labor costs did not change with the practice.

### Sudanese Sorghum – a heat-loving plant for large biomass production

One of the main problems for the Italian SOLMACC farmers was the soil fertility and nematode management. These were handled by including Sudanese Sorghum in the crop rotation. They produce large quantities of organic matter that are used as green manure. The farmer developed a management system to optimize the use of this plant and therefore improving soil fertility on his farm. He uses between 30-40 kg seeds per ha. His experience has shown that the soil does not need to be overly refined for the sowing, but in case of heavy rain events or too few rains, it is good to roll immediately after sowing. The crops will grow during summer and autumn and crops can be sown in the following spring season. During this time, the grass can be cut two times, where the second time it can be left on the ground throughout the winter. By this, excessive loss of soil organic matter is reduced. Before spring sowing, the biomass should be incorporated into the soil. The farmer has also experimented with a technique where green manure (Leguminosae or Graminaceae) is crushed by a roller crimper and not buried. The vegetable crop is transplanted or sown in furrows produced, thus playing a role of natural mulching with burial at the end of the cycle.





## Mannucci Droandi: Permanent Grass & Vineyards

### Farm Description

**Mannucci Droandi** is a family farm located in the hamlet named Caposelvi, about 35 km far from Arezzo. The production is based mainly on **olive oil and wine** according to the standards of organic farming. The farm consists of **two areas: Campolucci and Ceppetto**. The former is located on the eastern slopes of the Chianti Mountains at an altitude of 250 m above sea level. The second part of the estate, Ceppetto, consists of vineyards and olive groves surrounded by dense oak and chestnut woodland. It is situated on the west side of the Chianti mountains at 350 m above sea level.

### Farmer Statement

*"I hope that SOLMACC will spread innovative sustainable techniques and improve farming methods countering climate change!"*

### Nutrient Management

**Compost is produced from marc and prunings from vines** (around 1500 – 2000 kg/year), and other on-farm residues. The compost is distributed in vineyards and olive groves and therefore **helps to close on-farm nutrient cycles**.

**CO<sub>2</sub> Reduction: - 49 %**

Composting marc helps to reduce CH<sub>4</sub> and N<sub>2</sub>O emissions, compared to the emissions of a residue pile.

**Climate Change Adaptation Benefit:** ☒ ☒

#### Co-benefits of Compost:

- Reduces the number of viable seeds in the fertilizer, and soil erosion.
- A stabilized organic matter.

#### Economic Viability: €€

The farmer's experience shows that spreading the compost increased his crop yields significantly. However, at the same time, more operational costs occurred, while input/labor costs were maintained.

### Crop Rotation Management

The farm introduced **green manure with seeding, in the vineyards and olive grove** on 31 ha. The green manure consists of different graminacea, bee pasture (Phacelia) and clover. It is cut 3-5 times a year and utilized for the compost production or directly left on the field as a fertilizer for the vineyards.

**CO<sub>2</sub>-eq. Reduction: +5 %, because the practice requires more machinery input**

Legume crops contribute to N fixation and therefore, reduce the amount of fertilizer needed in the following years.

**Climate Change Adaptation Benefit:** ☒ ☒

#### Co-benefits of green manure mixed in vineyards:

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

#### Economic Viability: €€€

The farmer's experiences show that with the changes in his crop rotation management, yields and all associated costs did not change.

### Tillage Management

Farm **avoids plowing on the 31 ha vineyards and olive groves**. Instead, a **permanent grass cover** is cultivated with 2-4 passages per year with spring harrows or disks that are used to aerate the soil.

**CO<sub>2</sub>-eq. Reduction: - 26 %**

Avoiding tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒ ☒

#### Co-benefits of Reduced Tillage:

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

#### Economic Viability: €€

The farmer's experience shows that crop yields increased significantly, while operational costs increased. Input and labor costs were maintained.

### Agroforestry

The farm consists of **8 ha olive groves, 25 ha vineyards and around 1 ha boundary trees** along the fields. The boundary trees were diversified, and new trees were planted (e.g., Robinia and Oak). Additionally, the farmer introduced a rare, nearly extinct chicken breed into the vineyards.

● **CO<sub>2</sub>-eq. Reduction: Around 27.2-207.4 t C/ha are sequestered annually in the soil, and tree biomass.**

Trees help to sequester atmospheric carbon into plant biomass and soils. Therefore, they function as a carbon sink.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Woody Elements:

- Living habitat for diverse animals (biodiversity protection).
- Diversified income source.

**Economic Viability:** €€€

The farmer's experience shows that crop yields were maintained, while input/operational and labor costs did not change with the practice.

### Vineyard Cover - improving soil fertility

The experience of the SOLMACC farmer Mannucci Droandi has shown that a permanent grass cover of the vineyards helps to:

- Increase soil microbial activity.
- Promote a more intense humification process, as the mineralization of the organic substance, is more homogenous.
- Improve soil structure and reduce runoff in case of heavy rain events.

To reduce the operational effort of grass cutting, the growth of the grass must follow the course of the season. At the beginning of the vegetative period, it must be strong to slow down the vigor of the vineyard and stimulate the biological activity of the soil. It must then gradually be reduced until it is no longer needed in the critical summer phase.





## Azienda Agricola Tamburello: Olive Groves and Green Manure

### Farm Description

The Tamburello farm is placed in the valley of the Belice river, on the “Wine Route” (Palermo-Sciacca), linking up the Tyrrhenian Coast to the Channel of Sicily. It covers about 60 hectares, and the land is very diverse with vineyards, olive groves, and cereal production. It is a family farm with the belief that a healthy soil, cultivated with patience, love, and effort can give life to products of excellence. In addition to the attention to the quality of the products and, therefore, to the choice of implementing the organic farming practices, the Tamburello family is particularly sensitive to the environmental issues. The company aims to reduce greenhouse gases emissions, and for this reason, it decided to **install a photovoltaic system providing more than 90% of the company’s energy needs.**

### Farmer Statement

*“Participating in SOLMACC, I would like to be part of a strong European network!”*

### Nutrient Management

Before the SOLMACC project, the farmer did not use organic fertilizers. Therefore, it was planned to compost wine and olive production residues. However, it was difficult to find a right place for the compost production. Therefore, now the farmer uses his green manure to optimize his nutrient management.

### Crop Rotation Management

In the olive groves (15 ha), green forage manure, consisting of a **mixture of leguminous (Trifolium spp.) and Graminaceae, is cultivated.** Instead of leaving the soil coverless. The green manure is cut 1-2 times per year with a shredding machine.

#### ● CO<sub>2</sub>-eq. Reduction: - 99 %

Legume crops contribute to N fixation and therefore, reduce the amount of fertilizers needed in the following years.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of green manure in olive groves:

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

#### Economic Viability: €€€

The farmer's experience shows that with the changes in his crop rotation management, yields increased, while operational/input costs were maintained. At the same time, labor costs were reduced.

### Tillage Management

The farmer **reduced the tillage depth** in the olive groves (15 ha) from up to 20 cm depth to 5-10 cm.

#### ● CO<sub>2</sub>-eq. Reduction: - 3 %

Reducing the depth of tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Reduced Tillage:

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

#### Economic Viability: €€€

The farmer's experience shows that crop yields increased, while all other costs (operational/input/labor) could be reduced.

### Agroforestry

The farm has around 5333 vine and around 333 olive trees.

● **CO<sub>2</sub>-eq. Reduction: Around 28-213.5 t C/ha are sequestered annually in the soil, and tree biomass.**

Trees and hedges help to sequester atmospheric carbon into plant biomass and soils. Therefore, they function as a carbon sink.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Woody Elements:

- Living habitat for diverse animals (biodiversity protection).

**Economic Viability:** €€€

The farmer's experience shows that crop yields were maintained, while input/operational and labor costs did not change with the practice.

### Olive Grove Management with a Green Manure Cover

Olive trees require organic fertilizer during two separate phases of the year. First, during April/May for flowering and second, during August for the enlargement of the drupe. The Tamburello farm cultivates green manure with favio (broad bean) to support the olive grove growth during the first phase. With time, the green manure can evolve towards a permanent canopy. In between rotary cutter mowers and cutterbar mowers are used by the farmers, as they are comparatively light in weight and require little energy to function. These are used with a reduced tillage depth of 5-15 cm maximum. By this, root development is not interrupted. However, it is essential to study the local soil first. A prerequisite for the reduced tillage depth is the absence of soil compaction. Then, a reduced tillage depth can help to improve soil fertility and also reduce evaporative water losses, a substantial climate change adaptation benefit for Italian farmers in dry regions.





## Hånsta Östergårde: Mobile Livestock Systems

### Farm Description

The organic farm Hånsta Östergårde is located about 90 km north of Stockholm. The farmers, Kjell and Ylva Sjelin, cultivate about 160 hectares of farmland with a crop rotation roughly consisting of two years of ley, wheat, oats, peas or field beans, rye, and barley. Additionally, they have 10 hectares of permanent pastures, 57 ha forest and mixed animal husbandry with cattle, sheep, pigs, and hens. Kjell and Ylva are passionate about developing agricultural practices that decrease the amount of carbon in the atmosphere.

### Farmer Statement

*"Agricultural challenges are that we now must repair the life supporting systems such as a stable climate and beyond producing more food for more people. We want to take part in the implementation of these two tasks."*

### Nutrient Management

All animals are kept outdoors during the whole year. In winter time they are kept on arable land with access to open, mobile shelters with straw bedding. The sheds are moved when the straw beds are 40-50 cm thick. When they do field operations in the spring, the bedding material is spread and harrowed into the ground. Spreading and harrowing are done simultaneously to get the manure directly in contact with the soil to minimize ammonium losses.

#### ● CO<sub>2</sub>-eq. Reduction: - 85 %

The direct deposition of the manure to the soil minimizes emissions from manure storage. The transport of manure is eliminated which saves diesel.

**Climate Change Adaptation Benefit:** ☒☐

#### Co-benefits of Mobile Livestock Systems:

- Time is saved when the manure does not need to be transported from the farmyard to the fields.
- The farm needs less manure storage capacity which saves concrete.

#### Economic Viability: €€€

The farmer's experience has shown that crop yields and input, operational and labor costs could be maintained at the same level. Capital is not stock in big buildings and surfaces for manure storage.

### Crop Rotation Management

The farm introduced a triticale-winter pea mixed culture. This improves yield stability of peas compared to cropping in monocultures. The protein yield per ha is increased. Also, the farm has maintained that around one-third of the area is cropped with forage legumes in the crop rotation (2 out of 7 years).

#### ● CO<sub>2</sub>-eq. Reduction: - 21 %

Legume crops contribute to N fixation and therefore reduce the amount of fertilizers needed in the following years.

**Climate Change Adaptation Benefit:** ☒☐

#### Co-benefits of Legumes:

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

#### Economic Viability: €€€

The farmer's experience has shown that crop yields and input, operational and labor costs could be maintained at the same level. The winter peas are highly appreciated by the market for human consumption.

### Tillage Management

The farm reduces tillage activities by seeding spring and winter cereals simultaneously in the spring. The winter cereal grows slower and stays low until the spring cereal is harvested. It is then overwintered and harvested the next year.

#### ● CO<sub>2</sub>-eq. Reduction: - 4.6 %

Reducing tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒☐

#### Co-benefits of Reduced Tillage:

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

#### Economic Viability: €€€

The farmer's experience has shown that crop yields did not change, while input and operational costs could be maintained. At the same time, labor costs could be decreased.

### Further Information

The experience of the farmer is that in 1 year out of 4 you need to seed in the autumn due to a weak winter cereal crop. Often the winter cereal becomes weak as a consequence of a high yielding spring cereal crop.

### Agroforestry

The farm has established an alley-cropping system on one of the fields. The tree rows consist of hazel, apple, pear and sea buckthorn. Between the rows a regular organic crop rotation is cultivated.

Additionally, during summer, the pigs are kept in the part of the forest that has recently been, or soon will be, logged and by rooting they help the natural re-plantation of the trees while they also fertilize the ground.

● **CO<sub>2</sub>-eq. Reduction: 80-162 t C/ha sequestered annually in soil, tree biomass and hedge biomass**

Trees help to sequester atmospheric carbon into plant biomass and soils. Therefore, they function as a carbon sink.

**Climate Change Adaptation Benefit:** ☒☐

### Co-benefits of Alley Cropping:

- Living habitat for diverse animals (biodiversity protection).
- The fruits from the rows secure a diverse access to food, and income for the farmer.
- Pigs help to reduce the need for soil management in the forest.

### Economic Viability: €€

The farmers experience has shown that crop yields and input costs could be maintained, while operational costs decreased. At the same time, labor costs increased.

### Mobile Livestock Manure Management

The manure management at Hånsta with animal husbandry on arable land is a promising management strategy resulting in lower emissions and lower investment cost for manure storage. During the winter animals are kept on arable fields with mixed grass with access to movable weather shelters.

Grass silage is fed during the cold season on the grassland. Straw is harvested in nearby fields and stored on the grassland. The manure littered beds are spread on the neighboring grain fields or the winter grassland just before spring tillage. Manure collection starts normally when the grazing is reduced in early November.

Gathering of manure ceases completely around the 10<sup>th</sup> of May. The collected manure originates from different location types:

- the beddings in the shelters (45%),
- the outdoor beddings on the grassland (25%),
- around the movable silage bale feeders (10%)
- the rest of the manure ends up randomly distributed on the grassland (20%).





## Körslätts Gård: The Economics of Establishing Biodiversity Strips

### Farm Description

Körslätts farm is located in the most southern region of Sweden, and the farm is organic since the year 2000. Here the farmer Magnus Bengtsson cultivate 130 ha of arable land and has 90 ha forest land. The farm also has the potential of producing 42,000 organic chickens per year in batches of 4,800 animals every five weeks. When there are chickens on the farm, they are kept in mobile buildings in a rotational system within a permanent field.

### Farmer Statement

*"I think the project sounds interesting and see it as an opportunity to organize the job I already started on the farm. To refine and document the effects of different measures is meaningful."*

### Nutrient Management

The farm has chicken manure to manage and by introducing a new winter crop, winter oilseed rape, the farm can now utilize the chicken manure collected during summer already in the autumn. Earlier the manure was stored until spring leading to extra emissions of CH<sub>4</sub> and N<sub>2</sub>O.

#### ● CO<sub>2</sub>-eq. Reduction: - 15%

Better utilization of farmyard manure helps to reduce CH<sub>4</sub> and N<sub>2</sub>O emissions.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Manure Management:

- A new winter crop helps to diversify the crop rotation.

#### Economic Viability: €€€

The farmer's experience shows that crop yields and all other associated costs (input, operational, and labor) did not change with the implemented practice.

### Crop Rotation Management

Magnus Bengtsson changed parts of his crop rotation management. He **increased the grain legume production** (lupin and field beans) and therefore substituted parts of the cereal production. Rape seed has been introduced, which increase nutritional uptake of manure in the autumn. Maize for combine harvesting is introduced with success – an example of a crop that will be possible to grow in a warmer climate in Sweden in the near future.

#### ● CO<sub>2</sub>-eq. Reduction: -7 %

Leguminous crops contribute to N fixation and therefore, reduce the amount of fertilizer needed in the following years.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Crop Rotation Changes:

- Maize is a very suitable cereal for chicken feed. Thus, livestock feed imports can be avoided.
- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

#### Economic Viability: €€

Crop yields did not change, while operational costs decreased and input costs increased. At the same time, labor costs could be reduced.

The grain legume crops are sold to human consumption to a good price making these crops rather profitable.

#### Further Information

The farmer participates in a research project aimed at increasing human consumption of plant protein and therefore they cultivate lupine and field beans.

### Tillage Management

Magnus Bengtsson **reduced the depth of tillage** from 25-20 cm to 15-20cm for all of his arable crops.

#### ● CO<sub>2</sub>-eq. Reduction: -0.7 %

Reducing tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Reduced Tillage:

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

#### Economic Viability: €€€

The farmer's experience shows that crop yields and input costs could be maintained, while operational and labor costs could be reduced.

### Agroforestry

During the project, the farm has managed a 600-meter long riparian buffer zone on both sides of a watercourse running.

● **CO<sub>2</sub>-eq. Reduction: 1.5-13.5 t C/ha sequestered annually in soil and hedge biomass**

Hedges and trees help to sequester atmospheric carbon into plant biomass and soils. Therefore, they function as a carbon sink.

**Climate Change Adaptation Benefit:** ☒☒

### Root Cutting Tools for a Reduced Tillage

On a medium heavy clay soil, Magnus Bengtsson has quitted plowing in the autumn in favor of ground cultivation combined with a root cutting tool (CMN couch grass killer). After the cultivation/root cutting, he sows radish to cover the field during the winter, catch nitrogen and let the deep roots help prepare the soil for next spring's crop. In the spring, he uses the cultivator a second time and thereafter sows directly in the soil. Compared to what he did before he saves hours and diesel on the field, and gets a better soil structure.

Magnus Bengtsson believes that he can manage without plowing on his clay soils, but that it will be difficult on the sandy soils, at least every year. On the fields where he quit plowing, he estimates that he reduces yearly costs by approximately 100 euro per hectare, without any effect on the yield income. But this is just the measurable economic benefit of the practice.

The biodiversity strips along with the creek nearby have improved pollination and general conditions for wildlife animals and insects. These provide valuable ecosystem services. When the project was started, this was seen as a waste of land among farmers. However, nowadays this practice is getting more and more popular.

### Co-benefits of hedgerow strips:

- On the farm, strips of flowers along the fields are managed and therefore, together with the hedgerows, increase biodiversity.

### Economic Viability: €€€

Crop yields and all associated costs (operational, input and labor costs) were maintained at the same level as the new practice.





## Sötåsen: Practical Education about Biogas

### Farm Description

Sötåsen is an agricultural college with an educational farm that is managed entirely organically since 1998. The farm has a significant share of self-produced feed. It also features experimental cultivation of protein crops such as lupine and field bean. Sötåsen has previously been working with training in economical driving, installation of solar panels and other energy-saving technology.

Part of the farm's agricultural college is the gardening students. Together, they experiment with integrating the gardening activities and vegetables with the agricultural crops to increase biodiversity.

### Farmer Statement

*"This project is fully in line with our long-term environmental work here at Sötåsen. Now we get the chance to take a step further and disseminate knowledge to our students. The exchange with other farms in Sweden, Germany and Italy feels great."*

### Nutrient Management

On this farm, the animal manure is subjected to anaerobic fermentation to generate and capture methane (CH<sub>4</sub>). This is burned in an engine to generate electricity and heat energy to replace fossil fuels. Liquid and solid residues are brought back to agricultural land.

#### ● CO<sub>2</sub>-eq. Reduction: - 200 %

The fermentation of animal manure in a biogas facility helps to reduce methane emissions and produces at the same time electricity and heat.

**Climate Change Adaptation Benefit:** ☒ ☒

#### Co-benefits of Biogas Plants:

- Producing own electricity increases the farm's resilience and independence.

#### Economic Viability: €€€

With the new practice established, crop yields increased, while operational costs decreased. Input and labor costs were maintained.

### Crop Rotation Management

The crop rotation consists of three years of ley followed by winter wheat, barley/oats/field beans, and oats which is under-sown with ley. Before the project, no field beans were cultivated.

#### ● CO<sub>2</sub>-eq. Reduction: +7 %, mainly due to new drying activities

Legume crops contribute to N fixation and therefore, reduce the amount of fertilizer needed in the following years.

**Climate Change Adaptation Benefit:** ☒ ☐

#### Co-benefits of Legumes:

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

#### Economic Viability: €€€

Crop yields, operational and labor costs were maintained, while input costs could be reduced with the new practice.



### Tillage Management

The farm avoids plowing after grain legumes. Furthermore, basic tillage operations are avoided for grass-clover due to the under-sown clover in oats.

● **CO<sub>2</sub>-eq. Reduction: -10.6 %**

Reducing tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒ ☐

**Co-benefits of Reduced Tillage:**

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

**Economic Viability: €€€**

Crop yields, input and labor costs could be maintained at the same level as the new practice. At the same time, operational costs decreased.

### Agroforestry

The farm has been installing a 300 m long windbreak hedge. The species selection was based on the somewhat challenging situation with a heavy rodent population. The selected hedge species are amelanchier, aroni, Rosa rugose, Corylus avellana, and Ribes alpinum. To minimize costs bulk plants produced from seed or cuttings was primarily used.

● **CO<sub>2</sub>-eq. Reduction: 0.6-5.4 t C/ha sequestered annually in soils, and hedge biomass**

Hedgerows and tree strips lead to C sequestration in above- and belowground biomass and in soil.

**Climate Change Adaptation Benefit:** ☒ ☐

**Co-benefits of Woody Elements:**

- Living habitat for diverse animals (biodiversity protection).

**Economic Viability: €€€**

Crop yields and all associated costs (input, operational and labor costs) were maintained with the new practice.

### Practical Education about Fossil Fuels, Soil Fertility and Organic Farming

On the entire farm, all the machines are run on HVO (hydrated vegetable oil). They also have trials with upgrading the biogas locally to be compatible with the tractors. All animals on the farm are fed with feed which is produced/cropped on the farm. On-farm heat treated field beans improve protein quality which means that external protein concentrate (e.g., soy) is not required for the high yielding cows. The heat treatment makes the protein more stable in the rumen, and more feed protein is directly absorbed in the small intestine.

The farm is integrated with a college, and all is organic which means that the students get a holistic education in organic agriculture and horticulture. This is an important platform creating a knowledge base for tomorrow's organic farmers. On the picture below students discuss together with farmers about the soil structure in the fields where low tillage is compared with regular plowing. This test was part of the **SOLMACC** project. The products from gardening are sold locally and in the school restaurant.





## Trägsta: Dairy Production and Animal Welfare

### Farm Description

Trägsta gård is located in a northern region of Sweden called Jämtland. It is organic since 2008, and they have 140 milking cows, 260 hectares of arable land and 20 hectares of grazing land. They experiment with several practices to reduce their impact on the climate and to improve overall environmental impacts.

*“We have worked hard to make our production more efficient and rationalized. Taking the step to streamline from a climate perspective seems like a natural next step. It is important to spread our experience to others.”*

### Nutrient Management

Manure is subjected to anaerobic fermentation to generate and capture CH<sub>4</sub>. This is burned in an engine to generate electricity and heat energy which replace fossil fuels. Liquid and solid residues are brought back to agricultural land and because of a higher percentage of N which is directly absorbable for the crop. This has increased the yields in the ley production.

#### ● CO<sub>2</sub>-eq. Reduction: - 85 %

The fermentation of animal manure in a biogas facility helps to reduce methane emissions and produces at the same time electricity and heat.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Biogas Plants:

- Producing own electricity increases the farm’s resilience and independence.

#### Economic Viability: €€€

The farmer’s experience has shown that crop yields increased largely with the new practice (more than 10%), while operational costs decreased. Labor and input costs remained at the same level.

### Crop Rotation Management

The farm has worked with optimizing their crop rotation to sync it with the feed management, aiming for as high proportion of roughage as possible. During the project, they switched from hired silage services to invest in their own machine line-up in order to better optimize harvest time and nutrient content.

The farm extended the utilization period of forage legume leys from 4 to 5 years by introducing innovative re-seeding techniques to avoid leys destruction.

#### ● CO<sub>2</sub>-eq. Reduction: -21%

Roughage from grass-clover leys are one of the most climate-friendly crops.

Increased proportion of roughage reduces the requirement for buying concentrate to the milking

cows and makes the farm more resilient and climate-friendly.

Legume crops contribute to N fixation and therefore, reduce the amount of fertilizers needed in the following years.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Legumes:

- Enhanced crop biodiversity on the arable fields, supporting a more diverse insect fauna.
- Higher soil fertility because of N fixation of legumes.

#### Economic Viability: €€€

With the new practice, yields increased largely (more than 10%), while operational costs decreased. Input and labor costs remained at the same level.

### Tillage Management

When joining the project, the farm started working with adapting the cultivation depth for plowing depending on field conditions. For most fields, the depth could be reduced from 20-25 to 10-15 cm.

#### ● CO<sub>2</sub>-eq. Reduction: -0.6 %

Reducing tillage helps to reduce fossil fuel consumption.

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Reduced Tillage:

- Potential increase of organic matter in the top soil.
- Helps to reduce soil erosion.
- Increases water holding capacity.

#### Economic Viability: €€€

While crop yields and input costs could be maintained, operational and labor costs could be reduced with the new practice.

### Agroforestry

The farm has a fenced mixed forest/grazing area on 15-20 ha. The area is now grazed by the young cattle, but they also cooperate with a neighboring sheep farmer to create a mixed grazing system. The goal of the silvopastoral system is to enhance grass production in areas which are now being forested while also focusing on the highest economic value on the trees which are left in the field. Pines are to be stem pruned for maximizing timber value while allowing more light to reach the ground. Some spruce is kept and sold as wood pulp. Birches are managed for firewood. Grey alders are kept as nitrogen fixers. Some junipers are saved for wildlife.

● **CO<sub>2</sub>-eq. Reduction: 4-5 t C/ha sequestered annually in the soil**

These practices lead to C sequestration in above- and belowground biomass and in the soil. Part of the woody biomass is used for heating and thus replaces fossil fuel (CO<sub>2</sub> mitigation).

**Climate Change Adaptation Benefit:** ☒☒

#### Co-benefits of Silvopastures:

- Living habitat for diverse animals (biodiversity protection).
- Diversified income source.

#### Economic Viability: €€

The farmer's experience has shown that crop yields increased, while operational and input costs could be maintained. At the same time, the labor effort increased largely.

### Dairy Cows, Animal Welfare and Climate Change

Good health and a long lifetime of the dairy cows are essential factors for a low carbon footprint of milk. The health of the dairy cows at Trägsta has improved significantly during the last 5 years from an already good standard. This is due to improved management methods and a good strategy involving staff and the whole family. Together, routines concerning cow comfort and animal welfare were improved at the farm. A higher proportion of roughage in the feed ration improves rumination and even the health of the cows. This farm has a management system which is a role model for organic dairy production which should be copied by more farms in the region and across Europe.



## INTEGRATE CLIMATE-FRIENDLY & RESILIENT AGRICULTURE

The SOLMACC project has shown that climate-friendly and resilient farming is possible in the European Union. However, if we want to achieve climate change mitigation goals in line with the recently ratified Paris Agreement, further efforts of all stakeholders are required. This means in particular that the farmers are not left alone with the burden of climate change mitigation and adaptation. It means that farmers are supported financially by policy instruments such as the CAP, but also by consumers that support a climate-friendly and resilient agricultural sector of the EU.

The project has shown that many different options exist to reduce GHG emissions on the farm-levels. They depend on the farm structure, but also on production systems, soil types, climate regions and last, but not least on financial capacities of the farmers. Farmers need to be supported to become aware of win-win situations, where they can decrease GHG emissions, while these measures help them to adapt to inevitable climate change impacts and at the same time increase their commercial revenues to make a decent living. Here, farm advisory services are the key to support a knowledge transfer between scientific understanding of mitigation potentials and farm practices.

The four overarching SOLMACC strategies, to optimize nutrient management, crop rotations, tillage systems, and to start agroforestry practices, are a good starting point for farmers to think about the questions where resources can be optimized, machinery equipment usage reduced or new farming practices implemented on the farm. However, not all of the above measures can be applied by every farmer in the European Union. This requires that farmers are again enabled to look at their farm from the climate perspective and supported to find locally adapted solutions.

The SOLMACC project has shown that mainstreaming climate-friendly farming practices requires role models for other farmers and consumers in a society that needs a quick change towards a sustainable future. The presented demonstration farmers have shown that there is a high motivation to transform the current agricultural practices and test new innovative ones. They have shown that it is possible to move towards a holistic farming system that integrates climate change mitigation and adaptation benefits that help farmers to stabilize or even increase crop yields while protecting our valuable ecosystem services.

We hope with this brochure to enable other farmers to become inspired for a climate-friendly and resilient agriculture systems in line with the EU policy goals. The great work at the participating SOLMACC demonstration farms motivates other farm advisors and farmers to realize the benefits that come along with climate-friendly and resilient farming. Policymakers must recognize the potential of organic farms to help achieve not only climate goals, but also economic benefits that come along. Finally, the consumers have to realize their role in this complex food system, to understand that farmers cannot do it alone, but we as consumers need to support them to overcome difficulties that might be associated with a sustainable production system.



## FURTHER READINGS

### ENGLISH LITERATURE AND LINKS

VIABLE CLIMATE-FRIENDLY FARMING: SOCIO-ECONOMIC STRATEGIES - [http://solmacc.eu/wp-content/uploads/2017/10/SOLMACC\\_socio-eco\\_broch\\_web-2.pdf](http://solmacc.eu/wp-content/uploads/2017/10/SOLMACC_socio-eco_broch_web-2.pdf)

Organic Farming, Climate Change Mitigation and Beyond: Reducing the environmental impacts of EU agriculture - [http://www.ifoam-eu.org/sites/default/files/ifoameu\\_advocacy\\_climate\\_change\\_report\\_2016.pdf](http://www.ifoam-eu.org/sites/default/files/ifoameu_advocacy_climate_change_report_2016.pdf)

Policy Recommendations: Increasing climate change mitigation and adaptation of the agriculture and food sector - [http://solmacc.eu/wp-content/uploads/2018/05/IFOAMEU\\_SOLMACC\\_policy\\_recommendations\\_FINAL\\_web\\_cover\\_20180518.compressed.pdf](http://solmacc.eu/wp-content/uploads/2018/05/IFOAMEU_SOLMACC_policy_recommendations_FINAL_web_cover_20180518.compressed.pdf)

What can organic farming contribute: <https://www.rural21.com/english/news/detail/article/what-can-organic-farming-contribute-00002609/>

Knowledge platform of farming practices: <http://farmknowledge.org/>

### GERMAN LITERATURE AND LINKS

KLIMAFREUNDLICHE LANDWIRTSCHAFT: SOZIOÖKONOMISCHE STRATEGIEN - <http://solmacc.eu/wp-content/uploads/2017/12/607-SOLMACC-DE-web.pdf>

**Valuable websites concerning climate-friendly agricultural practices:**

Bioland leistet aktiven Klimaschutz: <https://www.bioland.de/ueber-uns/bioland-themen/klimaschutz.html>

Klimawirkungen und Nachhaltigkeit ökologischer und konventioneller Betriebssysteme: [http://www.pilotbetriebe.de/download/Thünen\\_Report\\_29.pdf](http://www.pilotbetriebe.de/download/Thünen_Report_29.pdf)

Klimaschutz auf dem Biobetrieb: <https://shop.fibl.org/DEde/1552-klimaschutz.html?ref=1>

### ITALIAN LITERATURE AND LINKS

AGRICOLTURA SOSTENIBILE "CLIMATE FRIENDLY": STRATEGIE SOCIOECONOMICHE - <http://solmacc.eu/wp-content/uploads/2017/12/607-SOLMACC-IT-web.pdf>

**Valuable websites concerning climate-friendly agricultural practices:**

<https://aiab.it/category/progetti-e-ricerca/>

<http://www.aiab-aprobio.fvg.it/produttori/bollettini-lotta-guidata/>

### SWEDISH LITERATURE AND LINKS

MOT ETT KLIMATSMART LANTBRUK: SOCIOEKONOMISKA STRATEGIER - <http://solmacc.eu/wp-content/uploads/2017/12/607-SOLMACC-SE-web.pdf>

**Valuable websites concerning climate-friendly agricultural practices:**

[www.ekolantbruk.se](http://www.ekolantbruk.se)

[www.agroforestry.se](http://www.agroforestry.se)

[www.ekhagastiftelsen.se](http://www.ekhagastiftelsen.se)

[www.greppa.nu](http://www.greppa.nu)

[www.slu.se/epok](http://www.slu.se/epok)

**Are you further interested in this project?**

Visit [www.solmacc.eu](http://www.solmacc.eu)

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