Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Ekoforsk

Research projects within organic agriculture and horticulture

The Swedish University of Agricultural Sciences (SLU) coordinates a programme for research projects called 'SLU EkoForsk'. The aim is to improve the knowledge base for the development of crop cultivation, animal husbandry and the production of fruit, berries and vegetables.

Projects 2014-2016 (*project manager in brackets)*

Results from the projects are published at http://www.slu.se/ekoforsk
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Livestock on pasture

Automatic weighing as an animal health monitoring tool

Project Manager: Katarina Arvidsson, Department of Animal Environment and Health, SLU.

Project Group: Johan Höglund, Department of Biomedical Sciences and Veterinary Public Health, SLU; Henrik Österlund and Dan Rosenholm, Hencol AB.

Grazed semi-natural pastures are of great importance for the conservation of biodiversity in the Swedish agricultural landscape. Sustained biodiversity in pastures, however, requires management and thus grazing animals. As an effect of a declining number of potential grazing livestock, it has become increasingly difficult to maintain the management on these lands and thereby reaching the Swedish environmental goals. For farmers to choose to keep the animals on the semi-natural pastures and not on arable land or indoors requires, however, satisfactory production results on the pasture.

The goal of this project is to develop a novel method for animal health monitoring for grazing cattle. It will be based on a system for unmanned automatic precision weighing when kept on pasture, where alarms are obtained for animals with abnormal weight gain curves. The project focuses primarily on the detection of pasture borne parasite infections in calves, but the method could be further developed to include other diseases that impair animal growth performance. Thus we will try out if a new mathematical model of weight gain can be used for early detection of parasitic infection in calves.

At alarm, so called targeted selective treatment (TST) will be undertaken. This means that only the affected individuals are dewormed with an anthelmintic. An advantage of the TST approach is that the use of anthelmintics is minimised, which is in accordance with the rules of organic production. Comparison with conventional visual monitoring will be done, where our hypothesis is that the unmanned precision monitoring is better and reduces the use of anthelmintics. The method leads to increased animal health and productivity in livestock grazing biodiverse semi-natural pastures in organic production systems without prophylactic mass deworming.

The project is a collaboration between SLU with Götala beef and lamb centre and the company Hencol AB.

Northern highbush blueberries

Crop management in high tunnel and in the open field with emphasis on substrate and nutrients

Project Manager: Håkan Asp, Department of Biosystems and Technology, SLU.

Project Group: Siri Caspersen, Sammar Khalil och Birgitta Svensson, Department of Biosystems and Technology, SLU. Marie Olsson, Department of Plant Breeding, SLU.

The production of highbush blueberries is increasing worldwide. The world production is 330 000 tonnes and has been four-folded during the last three decades. In Sweden there are approximately 12 hectares of blueberries and some minor part in glasshouse production. Today organic production of blueberries is very limited, but is expected to have a great potential to expand as the berries are popular and have a good shelf life.

This project focuses on crop management of blueberries in high tunnel and in the open field with emphasis on substrate and nutrients. The fact that blueberries prefer acid soils raises several questions concerning suitable substrates in combination with mycorrhizal inoculation and fertilization in an organic production system. Field experiments with three cultivars of blueberries are established at Rånna Experimental Station, Skövde since 2011 aiming to optimize a sustainable production of high quality blueberries. Two different substrates is used, peat and bark or peat/bark mixed with forest soil. The effect of different organic fertilizers and mykorrhiza will be studied.

The project will investigate the possibilities of an optimized organic production of highbush blueberries in a Nordic climate and the main objectives are to:

1. Study plant performance in high tunnel and in open field, with regard to cultivars and substrates, differences in plant development, yield, pest problems and climatic adaption.
2. Investigate the importance of mycorrhizal inoculation for plant establishment and for the uptake of nutrients from organic fertilizers and on the inner quality regarding health beneficial substances. In this part of the project changes in the soil micro flora will also be investigated.

Couch grass

Cut fallow to replace black fallow

Project Manager: Göran Bergkvist, Department of Crop production Ecology, SLU.

Projectmember: Lars-Olov Brandsaeter, Bioforsk - Norwegian Institute of Agricultural and Environmental Research, Norway.

The control of couch grass in organic farming is largely based on repeated soil cultivations in autumn, i.e. during a period when tillage should be avoided due to the risk of causing increased nutrient leaching. The energy input for stubble cultivation exceeds by large the input needed for chemical control in conventional farming. Thus, intensive direct control of perennial weeds in organic agriculture is in clear conflict with the environmental goals of reduced nitrogen leaching and reduced use of fossil fuel.

We aim to contribute to the development of an organic agriculture with less use of soil tillage to control couch grass, by introducing a system were couch grass is controlled by a combination of competition, mowing and spading (spading = making parallel slits in the soil).

The objective of this project is to determine the importance of companion crop, cutting and spading strategy. We would also like to determine if the time from early spring to suitable time for winter rape and winter wheat sowing is enough or if the whole season is needed to achieve satisfactory effect. In a pilot study conducted within the EU project OSCAR (Optimizing subsidiary crop applications in rotations, http://web3.wzw.tum.de/oscar/) we have found that the amount of couch grass rhizomes late in autumn can be reduced by repeated cutting of a clover sward during summer and, more interestingly, that the effect can be strengthened by spading (with a spade) once in early summer.

We will start one experiment in 2014 and 2015, respectively, on an organic farm with a good stand of couch grass in Uppland. The four factors, companion crop, first spading, cutting and second spading will be investigated. The sub-plot size will be about 2m by 2m. A prototype machine developed by Bioforsk and Kverneland will be used for the spading.

Foot spray against digital dermatitis

Disinfecting with environmental-friendly hypochlorous acid as alternative to traditional foot bath with polluting copper sulphate or antibiotics

Project Manager: Christer Bergsten, Department of Biosystems and Technology, SLU.


Foto: C. Bergsten

Digital Dermatitis (DD) is a contagious claw disease, which secondary cause other claw diseases as heel horn erosion, interdigital hyperplasia, warts and lameness. Lameness is the most common cause of poor animal health, poor durability and large economic losses. Claw diseases and lameness is increasing in pace with the transition from tied to loose housed cows because of the infectious pressure increases and the feet are becoming more exposed to poor hygiene and trauma.

Primary prevention of these disorders and lameness, is biosecurity, good stall hygiene and proper management. Footbath with 8% copper sulphate solution currently recommended, has in Swedish trials been shown to reduce the risk for DD ten times compared to a water bath. However, copper is a pollutant covered by the European biocides directive.

The purpose of the experiment is to study an alternative method with foot wash and an alternative disinfectant that does not burden the environment to prevent and treat digital dermatitis and secondary claw diseases and lameness. The method is to spray the claws with a hypochlorous acid when the animals are milked in the milking robot. The hypochlorous acid is produced from water by addition of sodium chloride through an electric hydrolysis under constant pH 6.5. The solution is disinfecting after which it returns to water and sodium chloride.

- At the start of the trial all animals are trimmed and claw diseases are identified and recorded for each foot.
- The development of claw diseases is then followed up by 4-month intervals.

The result is assessed as the number of new and recovered cases under current observation period and compared between treated and untreated cows. The results are corrected for parity, days in milk, breed, and herd.

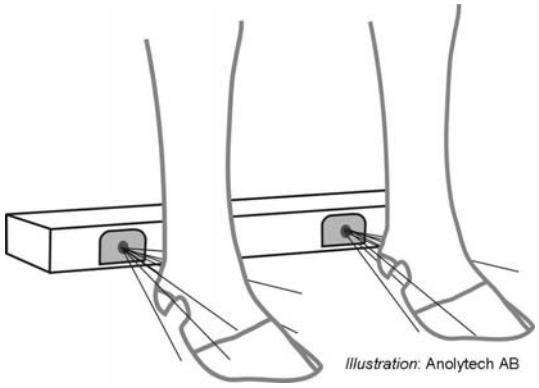


Illustration: Anolytech AB

Potatoes

Development of new hybridization material for improved resistance to late blight

Project Manager: Ulrika Carlson-Nilsson, Department of Plant Breeding, SLU.

Projektdeltagare: Nadezda Zoteyeva, Genetic Department of N. I. Vavilov Institute of Plant Industry (VIR), St Petersburg, Russia.

Due to the large susceptibility to many pests and diseases potato is one of the most problematic crops in organic agriculture. One of the worst threats is late blight caused by *Phytophthora infestans*. The alternatives in organic growing systems to reduce the damage of this oomycete comes down to the use of early maturing cultivars or to kill the haulm early, before the attack. Another alternative is resistant cultivars. Unfortunately the number of such cultivars is low. Today the organic sector is more or less dependent on cultivars from breeding programs for conventional agriculture. Even if many of the requirements of organic potatos are the same as for conventional, yield still has top priority in conventional production. At present this can not be first priority for organic growing systems. Here top priority instead has to be on late blight resistance, nutrient-efficiency and earliness.

In opposite to most potato cultivars of today many wild *Solanum* species are rich sources of resistance genes to *P. infestans*. Only a limited amount of the biodiversity has been used. In addition to several QTLs, around fourty different *R* genes conferring resistance to *P. infestans* have so far been found in different potato species. Today there is a renewed interest to combine multiple resistance genes to develop cultivars with a more durable resistance. The approach to use traditional hybridization techniques combined with marker assisted breeding to achieve adequate pyramiding of resistance genes from different sources to prolong the durability is well in agreement with organic principles.

In our project offspring from interspecific crosses between late blight resistant accessions from species like *S. berthaultii, S. neoantipoviczii, S. ruiz-ceballosii*, *S. guerreroense,* and *S. tuberosum* subs. *andigenum* as well as the hybrid *S. microdontum* × *S. tarijense* will be examined for the presence of different *R* genes and QTLs for resistance with the help of molecular markers. With guidance from the received results hybridizations with the goal to add additional resistance genes to these genotypes will be performed.

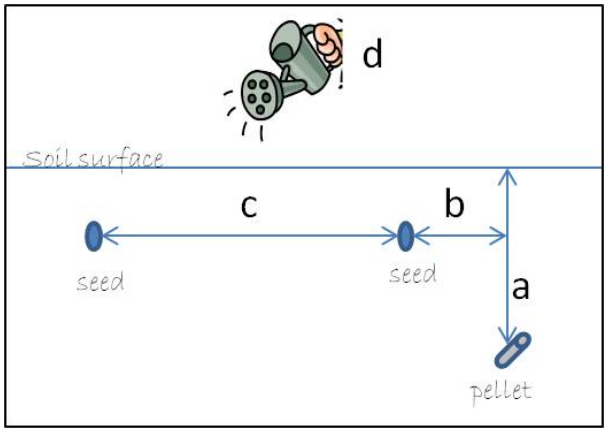
This breeding germplasm will later on be utilized in the already existing breeding program at the Department

Pelleted fertilizer

Optimal placement with regard to nitrogen use effeciency, weeds and grain yields

Project Manager: Sofia Delin, Department of Soil and Environment, SLU.

Project Group: Annelie Lundkvist, Department of Crop Production Ecology, SLU. Lena Engström Department of Soil and Environment, SLU.



Two key requirements for success in organic crop production are increased nitrogen use efficiency of organic fertilizers and reduced weed pressure. Placement of fertilizer close to the seed row and at appropriate depth could meet both these requirements. In this study, the effects of pelleted fertilizer placement will be investigated in manually managed microplots and in larger field trials, using currently available technology. The objectives are to answer the following questions:

1. Can the nitrogen use efficiency of pelleted fertilizers be improved by better placement with regard to soil depth and distance to the seed row?
2. Is weed pressure affected by pelleted fertilizer placement?
3. What soil depth and what distance from the seed row give the best yield effects?
4. Does the level of precipitation influence the importance of soil incorporation as regards fertilizer effects on yield?

Since there is no experimental equipment available that can achieve different depths of incorporation and distances to seed rows in a desirable way, this will mainly be studied in microplots, where fertilization and sowing will be done by hand. A few treatments will be tested in larger field experiments where seed and fertilizer are drilled with a Cameleon machine, which enables different row spacing and incorporation depths.

Tomato production

Combined biological control with microorganisms and biofumigation

Project Manager: Hanna Friberg, Department of Forest Mycology and Pathology/Centre for Biological Control, SLU

Project group: Anna Mårtensson, Department of Soil and Environment and Birgitta Rämert, Department of Plant Protection Biology, SLU. *Associated Partner:* Elisabeth Ögren, advisor for vegetable production at Länsstyrelsen Västmanland.

In organic tomato production, soil-borne plant diseases are one of the main yield reducing factors. Two of the most problematic diseases are the corky root disease, caused by *Pyrenochaeta lycopersici*, and fusarium crown and root rot, caused *by Fusarium oxysporum* f.sp. *radicis-lycopersici*.

These pathogens are producing resting structures in the soil, and their control is difficult since the soil cannot be sanitized between crop cultures - existing methods such as changing the soil, soil fumigation or heating are problematic and also restricted due to rules for organic production, costs, energy consumption and working safety requirements. Therefore, we will evaluate the potential of biological control agents (BCAs) already available on the Swedish market or in the development process, and soil amendments that can sanitize the soil and stimulate naturally occurring soil organisms with antagonistic activity against plant pathogens.

Although the interest for such methods to control diseases is high, the current use is limited. The variation among soils leads to differences in efficacy of BCAs and in the way the soil microbial communities respond to additions of organic material. Increased understanding about this variation and how the control measures can be adjusted depending on the soil will increase the potential for successful biological control in soil-based plant production systems. A

range of soils from Swedish tomato growers will be investigated concerning the ability of (BCAs) to colonize the soil and control soil-borne diseases, alone or following addition of organic material. The results will be of direct importance for organic tomato production, and the in depth findings are of interest for biological control of plant diseases in all types of soil-based plant production systems.

Functional botanical diversity

A path to robust cropping systems - with aphids in focus

Project Manager: Velemir Ninkovic, Department of Ecology, SLU.

Research Group: Robert Glinwood, Department of Ecology, SLU and Göran Bergkvist, Crop Production Ecology, SLU.

The overall aim of this project is to develop an approach to crop protection based on specific increases in the functional biodiversity of the crop, delivering stable yields and resilience against aphids with a smaller environmental footprint than conventional control methods. Our previous results from laboratory and field experiments show that chemical interactions between plants may reduce aphid plant acceptance, and attract natural enemies. In this project we will investigate the potential of mixing wheat and rye, to reduce pest aphid populations.

The aim is to contribute to the development of a robust crop production systems based on increased botanical diversity that contributes to a sustainable pest management and to reduce the need for emergency plant protection.

Our aim is to provide recommendations that can be used by both organic and conventional growers.

Apples

Application of ARs in an organic apple orchard for protection against storage diseases

Project manager: Hilde Nybom, Department of Plant Breeding, SLU.

Storage diseases caused by different fungi can lead to considerable economical losses in commercial apple production. This becomes especially severe in organic production where approved and efficient plant protection compounds are missing. In an Ekoforsk-project in 2011–2012, we (SLU-Balsgård and the Chemistry Department, Lund University) developed and tested a compound from rye bran.

The active ingredient is a type of phenolic lipid, alkylresorcinols (ARs). Newly harvested fruit, which had first been inoculated with spores of common storage diseases like blue mould, bitter rot and bull's eye rot, was subsequently sprayed with different AR-solutions. The best of these solutions resulted in significantly smaller symptoms when the fruit was evaluated after some weeks of cold storage. In a small field trial in 2013, AR-solutions were also sprayed onto organically grown trees of Aroma three weeks before harvest, which resulted in significantly fewer damaged fruits both at harvest (*Monilinia fructigena*) and after harvest (especially *Neofabraea* – the most serious storage rot).

In this new project, a block trial with 24 organically grown, 10–15 year old Aroma trees will be treated in 2014 with our best solution, AR1:

1. at bloom,
2. at four weeks preharvest,
3. at bloom and at four weeks preharvest and
4. at four weeks preharvest and at harvest.

Controls will include both unsprayed trees and trees sprayed with all ingredients except the AR. In 2015 a second apple cultivar will also be used. In addition, some newly harvested fruits from each AR x treatment will be subjected to various combinations of inoculation with two different fungi and to AR post-harvest treatment. If these analyses yield promising results, we will then apply for funding to develop methods for large-scale production and application of the AR-containing solution with a standard fruit spraying equipment.

Lamb production

Animal welfare through breeding

Project Manager: Anna Näsholm, Department of Animal Breeding and Genetics, SLU Uppsala.

The aim of the project is, through improvement of the breeding program for Swedish sheep breeds, to contribute to an organic lamb production that is economically, socially, and ecologically sustainable. Calculations done at SLU have shown that the financial result is better in organic than in conventional lamb production and higher profitability can be expected in organic lamb production. A well-organised sheep breeding program adapted to organic farming is a possibility to improve competitiveness in Swedish lamb production.

Organic production puts special demands on the animals such as ability to convert forage, disease resistance, survival, and longevity. In the current genetic evaluation a number of breeding values for important goal traits are calculated but the key traits lamb survival and ewe longevity are not yet included. A total merit index (TMI) weighing the economic, environmental, and ethical importance of the various traits is also missing. A TMI enables producers to work toward common breeding goals and the total genetic gain will be as high as possible.

To find which breeds are best suited for organic production we will study their results for productivity, fertility, lamb survival and ewe longevity in organic and conventional production, respectively, during the last ten years. Importance of herd size, location in the country and season is also illustrated.

We want to improve the current genetic evaluation by developing a basis for a TMI for Swedish sheep. The study includes estimation of genetic parameters for lamb survival and ewe sustainability, calculation of economic weights, and simulation of genetic gain. Data from Elitlamm, owned by the Swedish sheep breeding association, and KRAV will be used.

The purpose is to make it possible to select for functional, effective, and sustainable animals in organic sheep farms. The project is done in collaboration with sheep breeding organizations and organic farmers in Sweden.

Deep litter for sheep

Plant nutrient value and comparison of straw and reed canary grass as bedding materials

Project manager: Cecilia Palmborg, Department of Agricultural Research for Northern Sweden, SLU.

Project group: Gun Bernes, Department of Agricultural Research for Northern Sweden, SLU and Knut-Håkan Jeppsson, Department of Biosystems and Technology, SLU.

Swedish lamb production is increasing (from around 200 000 ewes in 2001 to almost 300 000 in 2012). About 20% of the production is organic. In winter, most Swedish sheep are kept indoors on deep litter bedded with straw. It is important to optimise the farm nutrient balance, especially in organic production, but knowledge about plant nutrient content and nitrogen losses in deep litter manure from sheep is scarce. If there is a composting process in the deep litter, the amount of bedding material needed to keep a good animal environment can be reduced. This process can however lead to increased gaseous losses.

Cereal straw is the most common bedding material, but some years it is expensive and hard to obtain. Reed canary grass (RCG) may be an alternative, however farmers have both negative and positive experiences of it. The aim is to quantify the plant nutrient content of deep litter from Swedish lamb production, as well as the loss of nutrients.

During two housing periods straw and RCG will be compared as bedding material for 36 lambs in 2 x 3 pens.

- Feed intake and
- lamb growth will be monitored as well as
- cleanliness and
- behavior.

All bedding material will be weighed and samples of feed and straw/RCG analyzed for nutrient content. Dust at straw/RCG distribution will be measured. The temperature in the beds will be monitored. After each period the beds will be weighed and samples taken for nutrient analysis. Plant nutrient balances will be calculated. The influence of composting will be studied by storing the deep litter outside after the first year, and inside after the second season. An economic evaluation will be made.

Fusarium in oats and spring wheat

Variety and species mixtures for healthy crops with high quality

Project Manager: Paula Persson, Department of Crop Production Ecology, SLU.

Projekt Group: Hanna Friberg, Department of Forest Mycology and Pathology/Centre for Biological Control, SLU. Anna-Karin Kolseth och Göran Bergkvist, Department of Crop Production Ecology, SLU.

The basic idea with this project is to prevent pathogen propagation by mixing cultivars or species with different disease susceptibility. The increase in genetic diversity gives in addition stability in the production. An undersown nitrogen-fixing crop would act as a barrier to further spread upwards in the canopy, when infected plant debris is present on the soil surface.

The project will focus on small grain cereals and the spread of the Fusarium fungus causing root and stem base rot as well as head blight. The Fusarium pathogen produces in addition mycotoxins, already in the field, which has caused major problems in Swedish cereal production in oats and wheat recently, also in crops not showing any symptoms of disease. *Fusarium graminearum* has been the cause of the problems producing the mycotoxin deoxynivalenol DON, which seriously affects both humans and animals. The detected DON in produced cereals has been very high and by far exceeded the EU-limits set for food. However, mycotoxins also affect monogastric animals and cereals are the main ingredient in feed for pigs. From 2015, all feed used in organic animal production is to be produced organically and half of it should be produced on the own farm. The pigs should have free access to roughage which during the winter season can be cereal straw, also known to include Fusarium mycotoxins.

To minimize the mycotoxin problem it is necessary to prevent Fusarium to establish and multiply. The project will study Fusarium development and mycotoxin production in crops specifically aimed for own farm pig feed production. Fusarium and mycotoxin development will be studied in field trials with three-cultivar mixtures of oats or spring wheat compared with each variety in pure stands, together with oat-pea and faba bean-spring wheat combinations. The plots will be inoculated with *F. graminearum* at the time for sowing.

Piglet production

Development of an organic production system where batch-wise group weaning is made possible by exploring the natural physiology of the sow

Project Manager: Ylva Sjunnesson, Department of Clinical Sciences, SLU.

Projekt Group: Ann-Sofi Bergqvist and Ola Thomsson; Department of Clinical Sciences, SLU. Lena Eliasson-Selling, Svenska Djurhälsovården.

The sows' possibility to synchronize oestrus after weaning is one key factor for a successful batch-wise breeding system and are fully explored in the conventional pig production. In current organic pig production systems this part of the reproduction biology of the pig has not been explored fully. This project aims to investigate if there are natural ways to synchronize oestrus of sows in organic piglet producing farms.

In Swedish organic piglet production it is common that sows are group housed during lactation. The reason for the group housing is that the sow and piglet must be allowed outdoor access from day 14 after farrowing and it is usually easier to provide outdoor access from a group housing pen than from individual farrowing pens.

However studies have shown that sows kept in groups during lactation were more prone to show oestrus and ovulate during lactation than sows kept in individual farrowing pens. This causes productivity difficulties since the batch wise breeding system cannot be maintained because there is no synchronization of oestrus after weaning opposed to conventional production systems. There is also a risk of endangering the within-farm-disease-control as an increase of mixing of piglets of different ages is a consequence of unsynchronized oestrus.

It is well know that boars emit signals that induce oestrus among sows. A study conducted in Denmark showed that a restrictive and controlled presence of a boar could induce oestrus during lactation.

The hypothesis is that an introduction of a boar during lactation could induce oestrus in receptive sows. If the time point can be successfully adjusted it might be possible to synchronize most of the sows after weaning, thus making it easier to maintain a batch-wise breeding system

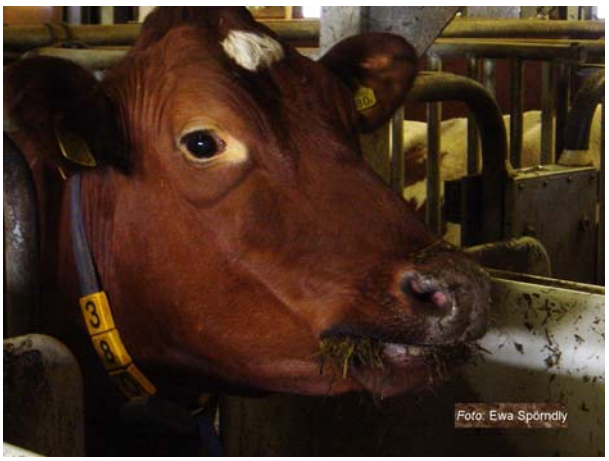
The project is collaboration with the Swedish Animal Health Service and is an attempt to create well documented recommendations that will be used to create a more robust organic pig production without tampering with animal welfare.

Total mixed ration for dairy cows

An economic feeding strategy for organic farmers with automatic milking?

Project Manager: Eva Spörndly, Department of Animal Nutrition and Management, SLU.

Project Group: Mikaela Patel, Department of Animal Nutrition and Management, SLU and Torbjörn Lundborg, Växa Sverige



Presently, approximately one third of the organic milk producers in Sweden have AM (automatic milking). Offering the feed as a total mixed ration (TMR) has proved to be a rational way of achieving a high feed intake and is therefore especially interesting for the organic producer. The problem is that TMR combined with AM is claimed to lead to low milking frequencies with low milk yields as a result.

Experiments that compare TMR with separate feeding in AM systems are few and do not cover the feeds and cow traffic systems common in Scandinavia. Furthermore, the response may differ depending on the type of cow traffic system that is practiced. Therefore the overall objective of this project is to study if TMR is an economical feeding system on organic AM farms and what type of cow traffic system is best in combination with TMR.

Feeding TMR will be compared with feeding forage and concentrates separately on diets calculated according to the rules for organic production. Three experiments will be performed, each lasting over a period of ten weeks and with a different cow traffic system: free cow traffic and two types of guided cow traffic systems. The guided cow traffic systems will be with selection gates where the cows with milking permission in one experiment will be guided to milking before the can access the feeding area and in the second experiment the cows will access the feeding area directly and those with milking permission will be guided to milking on their way back to the resting cubicles.

Production parameters, feed intake and cow traffic will be monitored automatically in the experimental barn. A field study will also be performed on commercial organic AM farms using diets with mixed feeds to study the advantages and disadvantages of combining AM with TMR.

Our hypothesis is that higher milk yields can be achieved with TMR (compared to separate feeding), but only when guided cow traffic is practiced.