Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Natural Resources and Agricultural Sciences
SLU EkoForsk

SLU EkoForsk - field research on organic production

The Swedish University of Agricultural Sciences (SLU) coordinates a programme for field research projects within organic agriculture and horticulture 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 should contribute to the development of a sustainable production in terms of environmental concerns, animal welfare, resource management, income level and productivity.

Projects 2014-2016 (project responsible within brackets)

Results from the projects are published at http://www.slu.se/ekoforsk
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Half the surface tilled – using row hoeing and under-sown subsidiary crops in a cropping system without heavy tillage

Project responsible: Göran Bergkvist, Department of Crop Production Ecology, SLU.

Project group: Per Ståhl and Anita Gunnarsson at The Rural Economy and Agricultural Societies in Östergötland and Skåne, respectively, Josef Appell and Joel Månsson, in collaboration with Gothia Redskap.

Establishment of winter wheat after oats intercropped with undersown annual legumes. *Photo:* Per Ståhl.

The overall aim is to develop a cropping system that benefit soil fertility, where the risk of erosion and nutrient leaching is small, and where weeds, pests and diseases can be controlled – but still provides the necessary conditions for large and sustainable yields, with a high proportion of cash crops in the rotation.

We want to achieve this by substantially reduce soil tillage, have crops growing during the whole year, and by using modern technology for weed control.

In our proposed system we will grow cereals sown in bands with wide row spacing in combination with row hoeing and under-sown subsidiary crops (SC). With modern row traction technology it is possible to sow different crops and till the soil in parallel rows. This means that we during a spring cereal – winter cereal crop sequence will be able to till the whole soil surface for weed control and at the same time use SCs to create good conditions for the second consecutive cereal crop.

The goal of the proposed project is to optimize the critical crop sequence, spring cereal – winter cereal, regarding yield, nitrogen use and weed control. We will use oats as model for spring cereals and winter wheat as model for winter cereals. We will compare under-sowing of different types of legume SCs and different row patterns for under-sowing of SCs. We will conduct on-station field experiments and full scale on-farm field experiments.

The on-station experiment will be used to optimise patterns of under-sowing and row hoeing depending on type of legume SC. The full scale on-farm experiment will be used to compare selected treatment combinations using commercially available farm equipment.

The importance of insect pollination for yield of field bean

Project responsible: Riccardo Bommarco, Department of Ecology, SLU Uppsala.

Project group: Sandra Lindström, The Rural Economy and Agricultural Society of Scania, and Ola Lundin, Department of Ecology, SLU Uppsala.


Photo: Per Modig

Organic meat production increases substantially, which has led to an increased need for protein feed. Purchased protein-rich concentrates and imported soybeans can be replaced by locally grown protein feed which optimizes and closes the nutrient cycle on the farm. The field bean (*Vicia faba* L.) can be cultivated to produce locally grown protein feed, and it is also in an important break crop that fixates atmospheric nitrogen, provides the organic crop rotation with nitrogen and improves the soil structure.

Increased knowledge about benefits, management, and underpinning ecology of ecosystem services such as pollination and biological control of pests, allows for sustainable ways to increase the productivity of field beans - so-called ecological intensification.

Field bean flowers are visited by a range of pollinating insects that can positively affect yields. Many of these pollinators are, however, negatively affected by habitat loss, decreased flower resources and pesticide use. It is unclear whether the presence of wild pollinators in Sweden is sufficient to fully pollinate field beans.

We will examine how the community of pollinators affects yield in commercial fields of field beans, and whether the addition of honey bee hives to field bean fields' increases crop yield.

We will also test if wildflower plantings added to field edges benefits pollinators as well as natural enemies to crop pests.

The project starts 2018.

Swedish organic lentils – cultivation strategies for production of an attractive food crop

Project responsible: Georg Carlsson, Department of Biosystems and Technology, SLU Alnarp, Sweden.

In collaboration with: Per Modig, HIR Skåne AB, Kristianstad, Sweden


Photo: Georg Carlson

This project will investigate possibilities to increase the Swedish organic production of lentil; a food legume that is perceived by many consumers as healthy, tasty and easy to cook, but for which almost all current Swedish consumption is based on import.

The weather and soil requirements for lentil cultivation are similar to those for pea, which means that lentils could potentially be grown on large areas in Sweden. However, due to their weak stems and low competitiveness against weeds, lentils are often overgrown by weeds – especially in organic production – and difficult to harvest due to lodging. Intercropping lentils with cereals, for example oat, improves the crop's competitive ability against weeds at the same time as the cereal plants provide support that reduces lodging.

With the aim to improve yield stability of lentils in organic production, this project will use field experiments at SLU Alnarp and Hushållningssällskapet Skåne to investigate how intercropping with different supporting crops (e.g. cereals, other grain legumes or other crops) combined with different methods for mechanical weed management influence weed abundance and lentil yields. Selected intercrop combinations and weed management strategies will also be evaluated in demonstration trials in farmers' fields.

The results of the project will provide knowledge for increased Swedish production of lentils in organic production, which in turn will provide new opportunities for organic farmers to benefit from the growing consumer demand for organic and legume-based food.

Control strategies against nightshade and hairy nightshade including short fallow and cover crops

Project responsible: David Hansson, the Department of Biosystems and Technology, SLU Alnarp.


Photo: David Hansson

Project group: Anders TS Nilsson and Sven-Erik Svensson; both at the Department of Biosystems and Technology, SLU Alnarp. Lars Andersson, Department of Crop production Ecology, SLU Uppsala.

Nightshade and hairy nightshade are two problematic weeds. Both species build up a seed bank, requiring long-term weed control strategies. The project aims to evaluate the effect, primarily on nightshade in an organic cropping system with;

- new potatoes,
- carrots,
- planted onion,
- cereals and
- cover crops.

The weed seed bank is reduced in the rotation through passive and active measures. As an active measure, a short fallow (stale seedbed) in July reduces the seed bank. Passive measures such as cover crops (phacelia, oilseed radish), autumn-sown cereal crops and ryegrass undersown into the cereals will suppress the weeds. Changes in weed population will be measured by determining the seed bank and by assessing the weeds in the field. This will help identify the control methods which in combination with the main and cover crops have the greatest effect on the weed's seed bank in the crop rotation and establish a sustainable weed strategy.

The initial crop rotation experiment, has been financed by Swedish farmers' foundation for agricultural research (SLF) and the Swedish Board of Agriculture, from 2014 to 2016. The new funding from SLU EkoForsk makes it possible to study the complete crop rotation cycle in total 6 years (5 year rotation + 1 year to study the end effect of the rotation with a cereal crop on the entire experimental field).

In this "continuation project", the same weed control strategy will be applied, but in order to reduce nitrogen leakage, the handling of cover crops will change through a modified tillage strategy. To increase nitrogen efficiency in the cropping system, the cover crops are harvested in late autumn and put into "the biogas bank". The nutrients in the digested residue are added back to a new main crop the following spring.

Parasite intervention in organic sheep flocks

Project responsible: Johan Höglund, Department of Biomedical Sciences and Veterinary Public Health (BFV), Section for parasitology, SLU.


Photo: Johan Höglund

Swedish organic lamb production is characterized by high standards of animal welfare and low use of medication. However, it is also recognized that it is difficult to carry on pasture-based organic lamb production without use of dewormers (anthelmintics).

Experiences from Swedish farms show that gastrointestinal nematodes (GIN) causing severe pathology and illness in sheep are problematic to control without taking advantage of anthelmintic drugs. How to effectively monitor and combat GIN in Swedish organic lamb production of today is largely unexplored.

In this project we are going to investigate and develop a risk-based methodology for GIN control by gathering sequential data on the infection dynamics from organic sheep flocks. The project outcomes will ultimately lead to targeted treatments (TT). This is a novel medication strategy where anthelmintics are used meanwhile animals are grazing on diversity-rich natural grasslands, but only after diagnosis of infection. Thus, usage of dewormers will be minimized but not at the expense of decreased animal health or welfare. Since the use of anthelmintics is preceded by diagnosis the TT method is accepted according to the organic production guidelines in Sweden.

The project will be carried out in close collaboration between parasitological expertise at SLU, advisors, sheep breeding organizations and organic lamb producers. Ultimately it will contribute to an increased welfare, productivity and profitability in organic lamb production.

Fertigation with organic nitrogen fertilizers in apple production

Project responsible: Helene Larsson Jönsson, the Department of Biosystem and technology, SLU Alnarp.

Project member: Helena Persson Hovmalm, the Department of Plant Breeding, SLU Alnarp.


Photo: Helena Larsson Jönsson

The aim is to evaluate and optimize the use of organic, liquid N-fertilizers (Vinass and Fontana) in drip irrigation systems. The project focuses on

- growth,
- yield,
- external (color, firmness, appearance)
- internal (sugars, organic acids) quality and
- fruit tolerance to fungal attack during storage.

Today, both yield and quality is far too low in Swedish organic apple production. The reason behind may be that solid organic fertilizers and manure, which are commonly used fertilizers, release N slowly and therefore N may not be available when the apple trees need it for growth and development. Because of the low quality of the fruit, the storability is reduced and the organic apples are often sold shortly after harvest.

Our project started in 2016 and will be financed by SLF/PA in cooperation with Kiviks Musteri and Äppelriket, until the end of 2017. We have started field trials both in an organic orchard and in an IP (integrated production) orchard in order to evaluate the potential of liquid organic N-fertilizers at different pest management strategies.

With the grants from SLU EkoForsk, we will be able to run the project for two more years in the organic orchard. As apple trees store nutrients in the biomass, you cannot see the full effect of fertilization strategies until the following year, and these extra two years will therefore increase the scientific value of the project.

The cooperation between SLU, Äppelriket and Kiviks Musteri provides a good platform for the exchange of knowledge between researchers, advisors and growers, so that the results, in addition to scientific publications, also are spread among people working within apple production. Ultimately, our project may lead to a competitive Swedish production of organic apples with fruits of good quality.

Development of non-chemical greenhouse control methods against cucumber powdery mildew – in collaboration with growers

Project responsible: Erland Liljeroth, the Department of Plant Protection Biology, SLU Alnarp.

Project members: Laura Grenville-Briggs and Mira Rur, both at the Department of Plant Protection Biology, SLU Alnarp,
and Margareta Hökeberg, Centre for Biological Control (CBC), SLU Uppsala.


Photo: Mira Rur

The most widely grown greenhouse crop in Sweden is cucumber. However, the organic production of cucumber is limited, mainly due to cucurbit powdery mildew disease (CPM), which causes severe yield losses. It is very difficult to control CPM without fungicides and control has been increasingly more difficult also in conventional cultivation due to development of fungicide resistance.

There are no biopesticides or biological control agents available in Sweden against CPM. Only two fungicides are currently registered for use against CPM in conventional production in Sweden. However, fungicide resistance has been reported in CPM populations and conventional growers are currently left to depend on only one fungicide and cultural practices as control measures against CPM. Organic growers rely on climate control, partially resistant cultivars, proper hygiene and sanitation measures only. Therefore, there is a great need for the development of alternative methods for the control of CPM both for organic and conventional cucumber production.

We have during recent years investigated the effect of a number of biocontrol agents, and biopesticides based on plant extracts or inorganic compounds. These alternative products were screened in medium-scale greenhouse experiments and their effect was compared with the fungicide regime. We found that ’Sakalia’ (based on extract of *Reynoutria sachaliensis*) combined with a wetting agent based on *Yuccah schidigera* provided efficient control of CPM. Some of the other products, e.g. silicon also had a significant effect.

The aim of this project is to develop efficient integrated plant protection strategies against CPM for Swedish greenhouse cucumber production in collaboration with growers.

Since the plant extract based product was very effective against CPM in research greenhouse trials our hypothesis is that it will give significant protection also in full-scale commercial greenhouses. We also hypothize that integrated use of biopesticides against CPM can make organic production of cucumber economically sustainable.

Does compact total mixed ration improve animal welfare in organic dairy herds?

Project responsible: Mikaela Patel, Department of Animal Nutrition and Management, SLU, Uppsala.

Projectmember: Cecilia Kronqvist, Department of Animal Nutrition and Management, SLU, Uppsala.

Total mixed rations (TMR), when all components in the diet are mixed together, may be beneficial especially for organic dairy herds, as it facilitates the use of homegrown protein feeds, which often are rich in starch and thereby can cause rumen disturbances when fed separately.

When feeding a TMR to cows in groups, there is a risk that the high-ranked cows may sort the diet and eat the more palatable concentrate parts to a higher extent than the roughage, leaving a less energy dense mix to the low-ranked cows. This makes the diet different for different cows and the intended and the consumed feed ration is not the same. This may also cause conflicts between cows when new feed is distributed.

A way to handle this risk is to make the feed mix more homogenous and dense, by soaking the concentrates and mixing the diet more thoroughly. However, this often results in a decreased particle size, which could possibly result in decreased rumination and decreased pH in the rumen. A positive effect could be that the homogenous feed reduces the eating time, thus giving the cow more time for resting and ruminating and for high-yielding cows in free stall systems, time is often limiting.

This study aims at investigating the effect of a compact TMR on

- sorting behavior,
- rumen environment,
- feed intake,

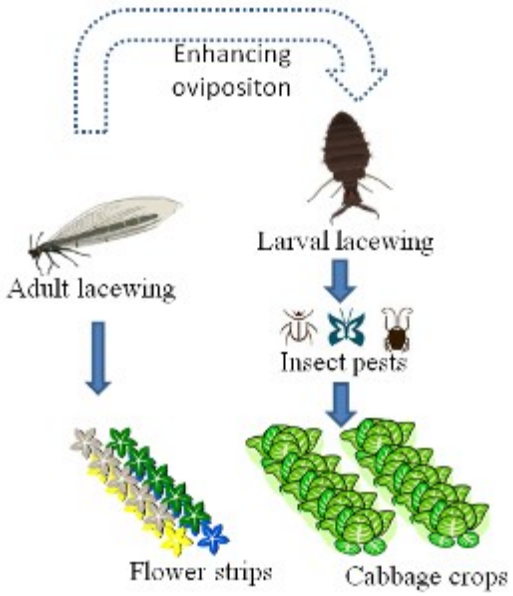
- milk yield,
- eating and rumination time and
- social interactions between cows.

This is studied in two different experimental change-over trials using both individual- and group feeding.

Chrysopidae family and flower strips as habitat management practices for control of cabbage insect pests

Project resposible: Marco Tasin, Department of Plant Protection Biology, SLU, Alnarp.

Project member: Belén Cotes Ramal,



Flower strips, flowering plants sown in strips or blocks along crop edges or between crop rows, can benefit predators and parasitoids because they require nectar and pollen sources to survive and reproduce. Among the natural enemies that rely on flowering substrates, Chrysopids (*Chrysopidae: Neuroptera*) use extra-field nectar sources and spread into surrounding crops, where they are reported to suppress pests. In Sweden, very few plant protection products are permitted in organic cabbage production to control important aboveground insect herbivores.

In intensive agriculture, lack of non-crop habitats has a negative impact on conservation of beneficial arthropods. Local manipulation practices can improve biological control by increasing the abundance and fitness of natural enemy species.

The hypothesis for this study is that different flowering plants growing in the vicinity of cabbage fields have considerable potential to enhance lacewings as biological control agents of insect pests, because adult lacewings can use these flowers as pollen and nectar sources and locate suitable oviposition sites in adjacent crops, where their larvae prey on immature stages of the most important cabbage pests (Figure 1).

The overall goal of this project is to reduce pesticide use for cabbage pest control by helping growers decide which flowering plants to use to promote lacewings.

The three specific objectives of this project are:

1. To screen for Chrysopidae populations in cabbage crops and examine the impact of flowering sources in their assemblages in a field experiment.
2. To qualitatively identify pollen contents of the diverticulum of Chrysopidae adults consumed in flowers of the strips.
3. To determine prey preferences of Chrysopidae larvae in the most important insect cabbage pests by PCR-based techniques for detecting prey remains in the gut of the larvae.

Reduction of campylobacter on broiler hybrids by feeding silage

Project responsible: Helena Wall, The Department of Animal Nutrition and Management (HUV), SLU.

Project group: Emma Ivarsson (HUV), Kamyar Mogodiniyai Kasmaei (HUV) and Patrik Ellström, The Department of Medical Sciences, Uppsala University.


Photo: Åsa Odelros

Campylobacteriosis is the most commonly reported zoonosis in the EU, causing intestinal infections and severe diarrhea in humans. Meat-type chickens (broilers) are the main source of infection. The outdoor rearing of organic broilers put new challenges on biosafety and the prevalence of *Campylobacter* is therefore much higher in organic broilers than in conventional. In order to avoid that organic chicken is associated with a potential threat to public health, measures are needed to inhibit the bacteria in chick intestines.

Previous studies have shown that lactic acid bacteria (LAB) have an inhibitory effect on the growth and survival of *Campylobacter*. Organic broilers must have daily access to roughage, and silage is routinely provided to chickens at some organic farms. Silage has a high content of LAB as well as organic acids and is therefore a promising option that could serve to reduce the levels of *Campylobacter* in the chick intestines.

The project begins with a fermentation study where different LAB inoculated in fresh forage prior to ensiling. When the fermentation is completed juice from the silages inoculated with different LAB are evaluated regarding their ability to inhibit *Campylobacter.* The LAB showing the greatest ability to combat *Campylobacter* is then used when producing silage for an infectious trial where all chickens are deliberately infected with *Campylobacter*.

In the infection experiment the candidate silage identified in the fermentation study will be given to half of the chickens while the others are given a roughage such as e.g. chopped alfalfa. The prevalence of *Campylobacter* in chick droppings are regularly analyzed and chick intestinal microbial profile are evaluated.

Finally, the prevalence of *Campylobacter* in chickens fed with silage compared with chickens given other roughage will be studied at organic broiler farms.

Are we controlling perennial weeds too late?

Project responsible: Theo Verwijst, the Department of Crop Production Ecology, SLU, Uppsala.

Project member: Anneli Lundkvist, the Department of Crop Production Ecology, SLU, Uppsala.


Photo: Anneli Lundkvist

One of the main challenges in organic farming is to achieve a long-term control of populations of perennial weeds, especially *Elytrigia repens*, *Cirsium arvense,* and *Sonchus arvensis*. Previous research has shown that these species are most vulnerable to mechanical control when the sprouting plants reach their minimum below-ground dry weight, i.e. the compensation point.

Earlier studies have shown that the compensation point occurred at 3-4, 5-7, and 8-10 leaves in *E. repens*, *S. arvensis*, and *C. arvense*, respectively. More recent experiments with *C. arvense* and *S. arvensis* however suggest that the compensation point occurs at earlier phenological stages. This would imply that control of those noxious weeds is performed far too late in current commercial practice.

Experiments will be performed to assess the compensation points of the main perennial weeds under field conditions and to evaluate the results of former and new experimental studies to

assess if and how compensation points vary under field conditions. Field trials will be performed in central Sweden during 2017 and 2018.

Root/rhizome fragments will be planted in spring and in autumn to assess the compensation point of spring-planted plants during the same year and of autumn planted plants the next year. Combinations of root weight, planting depth and crop competition will be used as experimental factors. Parallel experiments will be performed under controlled conditions.

Our hypotheses are:

1. The compensation points for the weed species occur at earlier phenological stages than described in the current literature.
2. The degree of fragmentation and planting depth do not affect the phenological stage at which the compensation point is occurring, but
3. cause a delay in phenological development of the weeds.

The project is expected to result in a revision of the advice for control of the species studied and thereby in a more efficient weed control.

Broiler hybrids, outdoor range and mapping of problems and factors of success on commercial organic farms

Project responsible: Jenny Yngvesson, Department of Animal Environment and Health; Section of Anthrozoology and Applied Ethology, SLU.

In collaboration with: MSc Åsa Odelros (Expert advisor for Organic Poultry Producers) and Sebastian Holm (Reko Kyckling – Producer of organic broiler meat), Anders Karlsson (professor of Meat Science at SLU) and Katarina Arvidsson-Segerqvist (researcher in Meat Science at SLU).


Photo: Anne Larsen

The variation within and between slow-growing hybrids appears to be large regarding productivity, behaviour, health and use of the range. This variation demands flexibility and adaptability from the farmers.

The long term aim of this research project is to contribute with new knowledge to enhance a sustainable development of Swedish organic broiler production.

The specific objectives are:

1. Assess productivity (feed conversion, mortality and meat quality), animal welfare (health, physiology and behaviour) and use of the outdoor ranging area
2. Identify key factors inhibiting development and success factors in management strategies, housing, production and animal welfare in commercial organic broiler flocks.

The project will run from 2017 to 2019 and is divided into two sub-projects:

- Evaluation of slow growing broiler hybrids

Part 1 evaluates variation and compares the commercially available slow growing hybrids Rowan Ranger and Hubbard Label Organic.

The experimental part 1 will be carried out at a farm in South West Sweden, in a stable suitable for this type of experiments. The broilers will be kept on litter with access to forage, perches and an outdoor range. Health, behaviour, utilization of the outdoor run, growth and feed consumption will be monitored during 10-12 weeks. Registrations will be carried out e.g. using the Welfare Quality ® protocol for broilers.

- Survey the production and animal welfare in commercial farms

Field data will be collected on-farms in order to describe and evaluate the management strategies, housing environment, production and animal welfare in approximately 10 organic broiler farms and at two poultry abattoirs. The broiler flocks will be visited at approximately the 9th week of rearing when the birds are approaching slaughter weight. The farmers' will be interviewed using protocols developed from protocols for similar investigations on organic pig farms (Wallenbeck, 2009).