

Rewarding cross-Atlantic cooperation

ICROFS has established a cooperation with the US Department of Agriculture, USDA, which has resulted in a joint conference with scientists from 12 OECD countries.

By Ulla Skovsbøl

ICROFS has hosted an international meeting for scientists from 12 OECD in cooperation with the US Department of Agriculture, USDA, financially supported by the OECD.

The meeting was held in Long Beach, California on the 1st and 2nd of November as a side event to the joint annual congress of three organizations: The American Society of Agronomy (ASA), Crop Science Society of America (CSSA), and Soil Science Society of America (SSA).

The key topic at the meeting was the challenges with the scientific research in organic food and farming systems is facing when, at the same time, trying to support sustainable food production and promote production systems with a high level of eco-system services such as clean water, high level of biodiversity etc.

Lise Andreassen, ICROFS international coordinator, was extremely pleased with the event:

"The speakers presented a great variation of interesting result from their research and the discussions were very inspiring. The conference proved that there is a common international focus on the interaction between production and productivity on the one hand and the concern for healthy eco-systems on the other," she says.

Read more: http://www.icrofs.org/Pages/News_and_events/2014Innovations%20in%20ORGANIC%20FOOD%20SYSTEMS%20Conference.html

Future CORE Organic funding to be decided

The future EU-funding of the ERA-Net CORE Organic will be decided in January. But eleven new transnational projects have already started within the existing program.

Eleven new transnational CORE Organic projects are about to start in the first months of 2015 with a total budget of 11.3 million Euro from 20 countries and with cofounding from the European Commission.

However, it is still not decided whether CORE Organic will continue with a new call at the end of 2016. The future of the program will be decided in January 2015 and depends on further EU funding.

"Personally I hope CORE Organic will continue forever, and since there always will be a need to support the organic sector's development with research, why not?" says Ulla Sonne Bertelsen, ICROFS' coordinator of the European research consortium CORE Organic.



Marie Wivestad, director of EPOK – Centre for Organic Food and Farming at the Swedish University of Agricultural Sciences – welcomed scientists from the CORE Organic projects, as they met in Stockholm in October 2014. Photo: Marie Louise Andersen

"There are challenges in legislation which the sector struggles to fulfil, and at the moment there are derogations in, for example, the use of organic seeds, 100 per cent organic feed and non-organic ingredients."

"Researchers and food producers need to collaborate to find new solutions. Also, innovative ideas and research are needed to improve production, economics and the organic sector's contribution to public goods (e.g. reduction in use of antibiotics,

increase in biodiversity and a cleaner environment), including Europe-wide objectives such as animal welfare, resource efficiency and nature preservation," she says.

Read an interview with Ulla Sonne Bertelsen in International Innovation: http://www.coreorganic.org/pdf/CORE_Organic_Intl_Innovation_169_Research_Media.pdf

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CORE Organic seminar – a great networking opportunity

The third seminar of the ERA-Net CORE Organic was held in Stockholm in October. Project leaders, stakeholders and funding bodies from 14 countries participated and enjoyed the opportunity to share knowledge and to create network with stakeholders, funding bodies and each other.

Willemine Brinkman from the The Agricultural European Innovation Partnership (EIP-Agri) Service Point in particular highlighted the user perspective of the seminar and noticed that a lot of the projects had farmers involved in the entire research process.

“There is a need for more practice-oriented research. Scientists are often judged on whether their articles are published in peer reviewed journals, and not on whether farmers use this new knowledge. The ultimate goal for agricultural research is that it should benefit farmers and society as a whole,” she said.

Read more about the conference: <http://www.coreorganic.org/Pages/Artikler/MeetingStockholm.html>

More than 16,500 papers in Organic Eprints

Organic Eprints (www.orgprints.org) – the international archive for publications about research in organic food and farming systems – is continually developing. All papers from the Organic World Congress 2014 in Istanbul, Turkey, have been deposited in Organic Eprints. The papers from the scientific track can be found here. At present there are more than 16,500 papers in the archive, and it is the sixth-largest archive on agriculture in the world!

Researchers who deposit their papers in Organic Eprints increase their visibility, make their results better known by the end-users and other stakeholders, but are also increasing the number of citations. Organic Eprints gives stakeholders access to papers, which would otherwise be difficult to obtain, and funding bodies get an easy overview of the output from projects – e.g. the publications from the ERA-net CORE Organic II.



The scientists of the AuthenticFood project have so far tested the new methods to detect organic food fraud in tomatoes, but also in durum wheat, pasta and tomato sauce.

Photo: Colourbox

New methods can reveal organic food fraud

New methods can detect whether or not a plant is organically grown. The methods are developed by the AuthenticFood consortium funded by CORE Organic. Preliminary results were presented in Stockholm in October.

By Marie-Louise Andersen and Ulla Skovsbøl

Organic food fraud might be easier to reveal in the future, when new testing methods invented by the Authentic Food Consortium have been fully developed. So far the methods have been successfully tested in e.g. tomatoes. The preliminary results, presented at a scientific seminar in Stockholm in October, are promising:

“We have developed and tested a portfolio of analytical methods such as stable isotope analysis of nitrogen and oxygen in specific plant compounds,” the project manager Kristian Holst Laursen explained.

“This work has shown that several methods are much better at discriminating the chemical composition of organic and conventional plants than the traditional pesticide residue analysis,” he told.

Despite several attempts to develop suitable analytical methods for organic authentication, pesticide residue analysis is still the most popular approach.

Pesticide residue analysis is insufficient

“But in some cases you actually find organically produced products which contain pesticide residues and conventional products which do not,” Mr. Kristian Holst Laursen said.

Pesticide residue analysis does not show whether the pesticides originate from the soil, the water or even from air pollution from surrounding conventional fields. Therefore, the analysis cannot reveal if an organic plant product has been produced according to the organic rules.

The final results of the research are still pending, but Kristian Holst Laursen and the AuthenticFood consortium will now encourage certification and inspection bodies to complement the insufficiently sensitive pesticide residue analysis with the new methods.

Two ProGrOV-students graduated in Nairobi

By Esther Wanjiku Waweru

Dr. Charles Owino Odhong and Ms Quintar Achola Genga graduated on Friday 5th Dec 2014 with a PhD (LPS) and MSc respectively.



Charles Owino Odhong was a student at the Faculty of Veterinary Medicine - PhD in Livestock Production Systems. His dissertation entitled: 'Integration of Organic Milk Production in Certified Smallholder Organic Farms.' The general objective of this study was to investigate potentials, challenges and prerequisites for improving milk production and quality on certified organic farms with integrated crop-livestock systems, and to identify the strengths and weaknesses in management at farm level.



Quintar Achola Genga was in the Faculty of agriculture- MSc in Sustainable Soil Resource Management and her dissertation entitled: 'Effect of Organic Based Soil Fertility Management Strategies on Soil Nutrient Status and Marketable Quality of Kales (Brassica Oleracea Var. Acephala) In Kiambu, Kenya'. The general objective of this was to assess the challenges of smallholder vegetable farmers and hence the contribution of organic based soil fertility management strategies on soil nutrient status and kale performance.

The ProGrOV project partners are very proud of the graduates. Their fellow students in the ProGrOV project, from University of Nairobi, Makerere University in Uganda and Sokoine University of Agriculture in Tanzania, will graduate in the coming year.



The Organic World Congress 2015 was held in Istanbul. Photo: Marie Louise Andersen

ICROFS put food security on the agenda in Istanbul

ICROFS hosted a successful workshop on food security and agro-ecology at IFOAM's Organic World Congress in Istanbul.

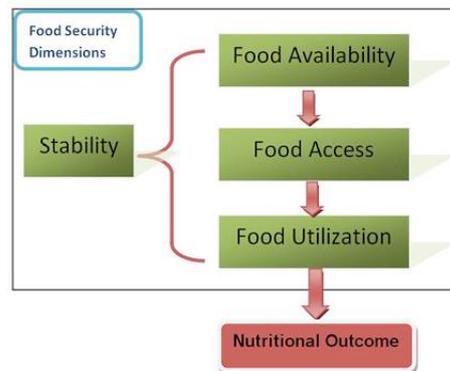
By Marie Louise Andersen

IFOAM's 18th Organic World Congress, held in Istanbul in October 2014, gathered more than 2500 participants from the organic sector worldwide.

At the congress ICROFS hosted a workshop on food security and on how it can possibly be improved by agro-ecological methods. The workshop was held in collaboration with Universidad Nacional Agraria La Molina (UNALM) in Peru, Hivos from Holland and IFOAM - International Federation of Organic Agriculture Movements.

The topic of the workshop is of major global importance, ICROFS' international coordinator Lise Andreassen says:

"On a global scale, the majority of farmers are poor smallholders with only a few hectares of land, and in particular in the developing countries the production of these peasants is of crucial importance to the local food supply. But despite this, they usually receive only little support, advice and help from outside," says Lise Andreassen, who was part of the organizing team.



These peasants will to a large extent be able to benefit from agro-ecological methods as a way to increase both the productivity and the sustainability of their production.

"But the existing knowledge and technologies must be adapted to the local needs. In order to bring about this development, more cooperation between farmers, researchers, authorities and NGOs is needed. And this is one of the key issue, we wanted to address in the workshop," she says.

An important part of ICROFS' vision is to convey knowledge about the new results of scientific research in organic farming and food systems, to mediate dialogue about organic farming and to promote agro-ecological farming systems as part of agricultural development both in the Global South and the Global North.

Heated debate on organic farming



Niels Halberg, director of ICROFS is highly critical to the approach of the scientist behind the book "Den Ekologiska Drömmen".
Photo: Ulla Skovsbøl

A heated debate on organic farming and food security has recently caught much attention in Sweden and Denmark. A book by four Swedish agro-scientists from SLU initially fueled the debate.

By Ulla Skovsbøl

"Experts in hard attack on organic farming: A disaster without profit". "Organic farming is a catastrophe for people and the environment" and "Pesticides are better than ecology" were only some of the lines shaping a heated debate that recently swept through Swedish and Danish media.

The debate was initiated by a new book: "Den Ekologiska Drömmen" (The Organic Dream) by four Swedish agro-scientists from the Swedish University of Agricultural Sciences (SLU).

Their view on organic farming is highly critical and they claim, it would be a total disaster if the entire farm sector in Sweden converted to organic farming. The book was first presented by the four authors themselves in a major Swedish newspaper, Svenska Dagbladet, and soon the debate flourished in papers and magazines, on TV and radio and in web-media all over Sweden. It also reached the Danish tabloid BT and Landbrugsavisen, the paper of the national farmers organisation in Denmark, Landbrug & Fødevarer, where the coverage was running several weeks.

Hard challenges

ICROFS always welcomes serious discussion on organic farming methods,

Niels Halberg, the director of ICROFS underlines. But according to him the recent debate has unfortunately to large extent been characterized by misunderstandings and misinformation.

"First and foremost ecology and organic farming is neither a catastrophe to humanity nor to the global environment. Organic farming methods are, however, in a process of development constantly trying to meet the crucial and complex challenges we are facing in the world of today," he says.

"The most critical challenge to modern farming is to ensure sufficient food production to a world population of more than nine billion people by 2050 and at the same time ensure that the production takes place in a sustainable way which does not destroy the soil fertility in the long term, but enhances biodiversity and other eco-systems services," he says.

"We need to preserve biodiversity, ensure clean drinking water and good ecological quality of the aquatic environment and prevent further climate change while we at the same time increase production. Organic farming is an attempt to develop farming methods which can meet these complex challenges," says Niels Halberg.

Serious misunderstandings

In "Den Ekologiska Drömmen" the authors claim that organic farming is less sustainable than conventional, less climate-friendly and that it cannot feed the world's growing population. Furthermore, it is not better for the environment, and organic food is not healthier than conventional food, the authors say.

"It would be a full-time job to qualify the debate by discussing in details all these allegations on a scientific basis," says Niels Halberg.

"Just to mention one example, there are many studies on the relative level of Green House Gas emission in organic agriculture versus conventional. And measured per unit produced there is generally little difference in the carbon footprint between organic and conventional products," Niels

Halberg explains.

"Organic cultivation often increases the carbon sequestration in the soil, and the CO₂ emission per ha is generally lower - but so are the yields. At the same time, there might be greater risks of nitrous oxide emissions from organic crop rotations due to use of catch crops and green manure," he continues. Sometimes organic products perform better than conventional - sometimes not. But in conclusion, it is not true that organic farming has a stronger negative climate impact. Organic farming methods are not perfect – but neither are the conventional methods," the ICROFS-director underlines.

Agro-ecology in the Global South

It is well documented and recognized – also by the UN - that existing conventional farming methods often destroy farmland and soil fertility and reduces biodiversity to an unacceptable degree. This is a serious threat to future global food security. Pesticides affect the biodiversity and can potentially contaminate the aquatic environment and groundwater resources and in addition, the negative effects of pesticides on human health are probably also underestimated, according to Niels Halberg.

So, in his view there is every reason to strengthen the scientific research in organic farming and agro-ecology both in the Global North and the Global South:

"At the global level, it is a mistake to perceive organic farming as a threat to food security. On the contrary, agro-ecological methods have in many cases proved to have a great potential to multiply the yields in poor countries," he says.

"The world needs this approach to develop sustainable food systems for the future which maintains and enhances the social and natural capital and ecosystems services, on which food production relies."

"There is a need for more radical innovation and development pathways in order to nourish the world. Organic and agro-ecological farming methods are part of the solution," Niels Halberg states.

New project provides knowledge on how agro-ecology can nourish the world

A new ICROFS initiative, the VOVE project, will provide insight in how to nourish the 2050 world population in a sustainable way through agro-ecology

By Mette Vaarst

The new ICROFS-led initiative, VOVE, aims at gathering information on agro-ecological farming and food systems worldwide, based on knowledge from several fields of expertise, including existing projects and current activities. The axis of the initiative is investigating how agro-ecology can meet the current challenges of climate change and food security.

The VOVE project will not only look at the food production itself, but also at how agro-ecological agricultural and food systems perform in terms of resource efficiency, sustainability and as means to nourish the human population in 2050 and beyond.

Agro-ecology is about building up the potentials of soil and the synergy between living organisms, rather than exhausting them, and about creating practices which maintain and enhance resources - natural, social and other resources. Agro-ecology combines science, practice and social movements.

The project will explore ways of using and researching agro-ecological farming and food systems in both the Global North and Global South. The VOVE project is a pre-project which will run until spring 2016 and explore a certain working hypothesis.



The working group behind the VOVE project and the project consultant Thomas Harttung gathered for a planning meeting in California in December 2014. Photo: The VOVE project.

WORKING HYPOTHESIS:

Complex, agro-ecological, functionally integrated food systems can be sustainable and nourish the world in 2050 with zero net emissions of greenhouse gases (GHG).

First, the project group will look into how this hypothesis can be investigated, and the relevance and feasibility of its different elements. Many very exciting studies and reports have been presented during the past years, and

many current projects are working on the ability of organic farming and agro-ecology to both nourish the future human world population and at the same time ensure the sustainability of natural and social systems.

One of the exciting and challenging aspects of the study is how to combine knowledge from the Global South and North. Another is to address a combination of global challenges: as a human population, we need to be productive, to distribute our food in a fair way, to reduce net greenhouse gas emissions from the agricultural and food systems, and to interact with social and natural systems including eco-system services in ways that sustain them and take planetary boundaries into consideration.

The acronym 'VOVE' means 'to dare' in Danish. This fits well with the ambitions of this project: We need both courage and audacity to dare to act on the serious global challenges which we as a human population are facing today.

The project is funded by The Villum Foundation <http://villumfoundation.dk>

Niels Halberg is the project leader, and the VOVE team also includes Lise Andreassen and Mette Vaarst, ICROFS.

VOVE Consortium

- International Center for Research in Organic Food Systems (ICROFS) - Coordinator
- University of Wisconsin, Madison (UW-Madison), Wisconsin, USA - and through UW-Madison linked with The Knowledge Systems for Sustainability Collaborative (KSS)
- The World Agroforestry Centre (ICRAF), and through ICRAF also the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS)
- International Center for Tropical Agriculture (CIAT) – and through CIAT, Soil Research Area linked with CGIAR research program on Water, Land and Ecosystems (WLE),
- Aarhus University (AU), Denmark
- Centre de Sciences Humaines (CSH), New Delhi, India, and through our partner here, contact to Centre Internationale de la Recherche Agronomique pour le Développement (CIRAD), France
- Research Institute of Organic Agriculture (FiBL), Switzerland

Hay-milk is suitable for high-quality cheese

Hay-cheese needs neither addition of nitrate nor mechanical pre-treatment of the milk due to high microbial standard. Yet, hay does not affect the fatty acid composition of the milk, and herbs in the hay do not influence the content of plant derived aroma compounds.



By Thomas Bæk Pedersen

This study of hay-cheese has been completed as a part of the EcoServe project. Hard cheeses were produced of milk from cows fed with hay that contained variable amounts of Danish herbs. In conclusion we found no differences in the content of plant derived aroma compounds in the cheeses. There were, however, some indirect differences in the microbial composition of the cheeses. Thus, in contrast to cheese made out of milk from silage-fed cows, high quality cheese can be made of hay-milk with no addition of nitrate to inhibit unwanted bacteria growth in the ripened cheese.

The aim of EcoServe

The overall aim of the EcoServe project was to increase the biodiversity in the grasslands and hence improve the living conditions of pollinating insects. Three different multispecies grass-clover fields with different Danish herbs were established in the southern part of Jutland and were used for hay production (table 1).

The different aspects of the EcoServe project have

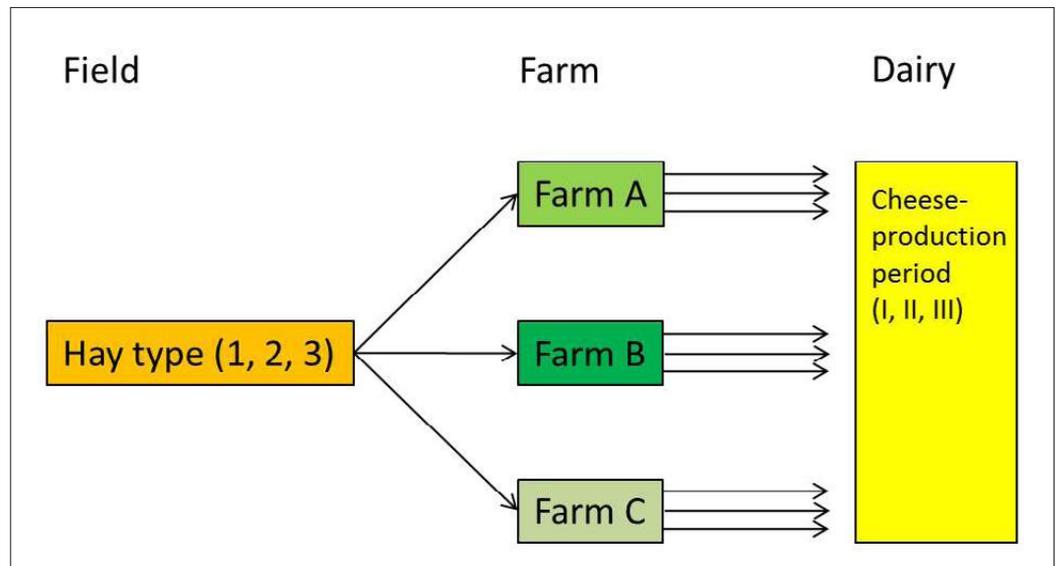


Figure 1: Schematic overview of the cheese production done in the project. Three feed types (feed 1, 2, 3) were feed to three dairy farms (A, B, C). Cheeses were made during three production periods (I, II, III) in duplicate from all combinations of dairy farm and feed type.

been covered in earlier ICROFS publications (1, 2). The cheeses were produced at Naturmælk, an organic dairy in Tinglev, and the analysis of the cheese was done at the Department of Food Science, Faculty of Science, University of Copenhagen.

Feed and cheese quality

Cheese quality depends on a number of factors of which the cow feed is of utmost importance. Studies from the southern part of Europe have shown that cheese made of milk from cows grazing on highland pastures can be distinguished from cheese made of milk from cows grazing on lowland pastures. The

most likely explanation to this is that herbs from the mountain pastures contain a variety of different aroma active compounds, which can be absorbed directly in the milk and potentially affect the smell and taste of the cheese. The content of herbs in the feed can also affect the fatty acid composition of the milk and e.g. lead to higher content of n-3 and n-6 fatty acids (3).

The cheese production

In the present study, cows on three dairy farms (A, B and C) were feed with three different types of hay (1, 2, and 3) produced on multispecies grass-clover fields. Farm A and B had Holstein Frisian and farm C had

Jersey cows. Hard cheese was made in duplicate with milk from all combinations of dairy farms and hay types, resulting in 18 experimental cheese vats (figure 1). Control cheeses were made from bulk-milk from cows primarily feed with silage. The cheeses were made in 800 liters cheese-vats (figure 2), using a traditional cheese starter and the cheese was ripened for one year before analyzing the content of aroma compounds.

The microbial composition of the cheeses was investigated along with the water content and pH and composition of fatty acids was determined in the milk samples. The milk used for



Figure 2: The cheese vat used for the production of the experimental cheese. The cheeses were made at Naturmælk in Tinglev.

the control cheeses were mechanically treated in order to remove detrimental *Clostridium* spores, which potentially can spoil the cheeses. Milk from hay-feed cows contains a very low number of these spores, and no pre-treatment was necessary.

Hay-milk has high quality

Fatty acid composition of the milk differed from farm to farm, whereas the feed type did not affect the composition of fatty acid. The dairy farm with Jersey cows (dairy farm C) had higher content of palmitic acid and long chain fatty acid (LCFA, C_{14:0-24:0}), and contained less C_{18:1} and monounsaturated fatty acids (figure 3).

The content of aroma compounds was dominated by compounds from microbial activities on the main constituents in milk; fat, protein, lactose and citrate. Only a few aroma compounds deriving from the feed were found, and there was no difference between the cheeses. The control cheeses contained significantly higher content

of a specific “house-flora” bacteria species, and the aroma compounds coming from these bacteria made it possible to distinguish between control cheeses and experimental cheeses. A loss of leaf-material was observed during the drying of the hay, and this could help to explain why the higher amounts of herbs did not lead to higher amounts of plant aroma compounds in the cheeses.

In conclusion, high quality cheese can be produced out of milk from hay-feed dairy cows with no addition of nitrate and no mechanical treatment of the milk to inhibit/remove bacterial spores from the milk. Further studies with alternative feed-types, such as silage with herbs where there is less loss of leaf material could potentially result in a higher transfer of plant aroma compounds to the cheese.

Main conclusions from the cheese making project

High quality cheese can be made from hay-milk

Hay-cheese can be made without addition of nitrate

and mechanical pretreatment of the milk

The different hay-types did not lead to any differences in the content of plant derived aroma compounds

No effect of the feed types on the fatty acid composition

The control cheese had a different microbial profile compared to the hay-cheeses.

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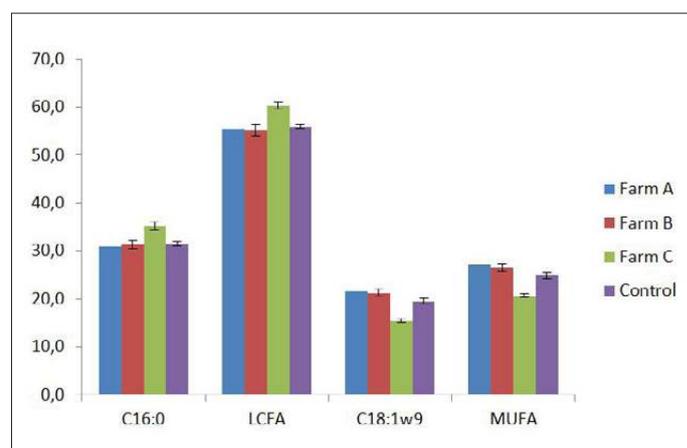


Figure 3: Content of selected fatty acids/groups in milk coming from the three dairy farms involved in the project. The values are mean of three milk samples analysis from the dairy farms where the cows have been feed three different hay types. LCFA (long chain fatty acids, C_{14:0-24:0}) and MUFA (sum of mono unsaturated fatty acids). Control milk was only analyzed once

Proteins from organic grown green crops are promising poultry feed

Proteins extracted from organic green crops have potential to substitute imported protein feed. In the organic RDD project OrganoFinery, the first small-scale tests to extract proteins from red clover and clover grass using a novel method showed good results, especially with respect to a favorable amino acid composition. The plan is to develop a feed product, containing organic red clover protein extract and test it in feeding experiments in poultry.



By **Mette Lübeck, Beatriz Molinuevo-Salces, Erik Fog and Pauli Kiel**

Organic farmers with monogastric animals (poultry, pigs and fish) are facing a number of challenges. The most serious are:

1. Sufficient supply of organic protein feed with the right amino acid profile at a competitive price.
2. Low crop yields of non-leguminous crops and low value of leguminous forage crops in organic crop rotations in areas with little milk production
3. Shortage of organic fertilizers.

Due to these challenges the organic farmers have to import feed and use manure from conventional farms. The over all target of the organic RDD project OrganoFinery is to provide solutions to these problems by developing a green biorefinery where the organic crops are at the same time used for animal feed, fertilizer and energy production (methane).

One of the project's aims is to identify crops suitable for organic arable farms with a general need for nitrogen. Sufficient nitrogen supply is essential for the production of protein, and therefore particularly legumes or mixed cropping with legumes are interesting for organic farmers as these crops accumulate nitrogen by biological nitrogen fixation. These crops are able to produce large amounts of protein, even when there is a low level of nitrogen in the soil and no use of fertilizers. Additionally, the legumes have a positive effect by contributing to the nitrogen supply to subsequent



Organic hen. Photo: OrganoFinery

crops and they have an important role to play in the crop rotation. Red clover has been chosen as a model crop in



Crops tested by OrganoFinery

- Red clover
- Clover grass
- Alfalfa
- Oilseed radish

OrganoFinery, but also clover grass, alfalfa and oil seed radish are being studied.

The first trials were carried out this summer in small-scale experiments on freshly harvested red clover and clover grass. Immediately after the harvest the biomasses of both crops were mechanically separated in a green juice and a press cake using a screw press (Figure 1). Organic protein feed was produced by lactic acid fermentation of the green juice. The extraction of proteins was based on an already developed technique to extract proteins from alfalfa. The method for separation of proteins from alfalfa was developed by AAUs subcontractor Biotest Aps in a joint Biorefinery program, BIOREF (FØSU grant 2101-08-0041) (Kiel, P. 2012). The alfalfa protein extraction method involved precipita-



Figure 1. Screw press utilized for the separation Photo: OrganoFinery

tion of the proteins with sulfuric acid, which in OrganoFinery is substituted with lactic acid fermentation in order to develop a process that is in accordance with organic principles.

The result of the fermentation was two fractions:

- 1) A protein paste, with non-denatured proteins suited for development of protein feed additive for poultry
- 2) A brown juice, which will be studied together with the press cake as a substrate for anaerobic digestion.

The intention is now to analyze whether the brown juice can serve as both C- and N-source and thereby substitute manure in biogas processes. Moreover, the digestate produced in the anaerobic digestion will be evaluated as organic fertilizer for the crops.

The protein yields obtained during the separation-fermentation process were in the range of 6 kg crude protein from one tonne of fresh biomass. The chemical composition of the protein paste from red clover is presented in Fig. 2. Crude protein contents up to 45 % in dry matter were obtained for both red clover and clover grass. Furthermore, the amino acid composition was determined for both crops and the results showed more favourable composition than the traditional soy protein for optimal poultry feed. In conclusion, the results from the first trial of the OrganoFinery project are promising with respect to devel-

op a novel feed product for organic poultry.

Mette Lübeck is project manager of OrganoFinery and Associate Professor at Aalborg University, Beatriz Molinuevo-Salces is postdoc at Aalborg University. Erik Fog is advisor in Organic Farming at the Knowledge Centre for Agriculture. Pauli Kiel is director at Biotest Aps.

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Protein sediment from red clover.

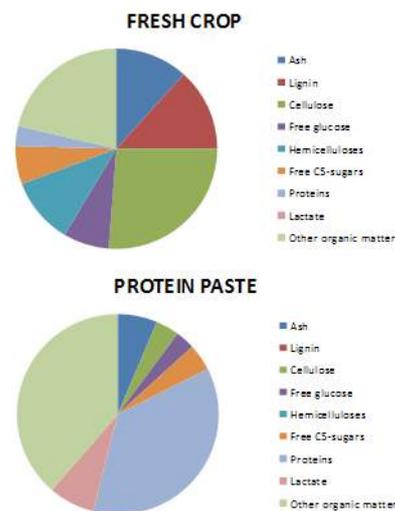


Figure 2. Chemical composition of red clover and the protein paste obtained in OrganoFinery (data are presented in grams per 100 grams of dry matter).



Clover. Photo: OrganoFinery



Pigs enjoy the outdoors, but so do parasites.

Parasitic worms – a challenge in organic pig production

Organic pigs have more intestinal parasites than conventional pigs. Yet, the contamination with parasite eggs and can be reduced by management procedures, the research project PAROL concludes.



By Helena Mejer, Tove Serup and Stig Milan Thamsborg

The research project PAROL (Organic RDD) has examined the occurrence of parasites in starter pigs (12-16 weeks), fattening pigs (22-26 weeks) and sows on five organic herds. Three intestinal parasitic worms were detected; the large round worm (main focus of the project), the nodular worm and the whip worm. Environmental contamination was mapped and potential control measures examined.

Nodular worms

This parasite is only 1 cm long and was most common in the sows. This is because this parasite somehow evades the pig's immune system. Pigs therefore accumulate this parasite over time.

Pigs are infected by tiny parasite larvae that develop from eggs excreted to the environment via the pig's faeces. The larvae are fragile so very dry, hot or cold weather will kill them quickly. Persistence of the parasite in a herd depends on continued excretion of eggs by pigs. It is therefore also reasonably easy to control. One year pasture rotation schemes substantially reduce pasture infectivity,

if combined with antiparasitic treatment during the cold winter months.

Large round worms

This 15-30 cm long worm was the most common. A single female worm can produce up to two million eggs per day. This was reflected in the contamination of both pastures and stables (Table 1). Most of the eggs are known to die, especially outdoors. However, the results showed that a few eggs can survive for at least 13 years in the soil.

The younger pigs (starter and fattening pigs) were the most infected. This is because pigs develop immunity against the parasite over time. This is illustrated by the generalized infection model in Figure 1 generated in the project. It is clear, that it is the growing pigs that are the most severely affected. This is a problem as the parasite may cause condemnation of livers at slaughter, reduced feed conversion and potentially reduce the effect of vaccines.

Whip worms

This 5 cm long worm is transmitted via very resistant eggs that also survive for many years. Each female lays very few eggs that develop very slowly. This explains why pig infection levels and prevalences were very low, though the parasite was present in all five farms. This is fortunate as it is the most pathogenic of the worms and high acute infection levels can cause pigs to die.

Parasite control

The high occurrence and resistant eggs make the large round worm the most challenging to control. This was therefore the focus of the second part of the project. Control of whipworms should follow the same guidelines as described for the large round worm below.

Pastures

Piglets on all farms were exposed to the large round worm

Table 1. Mean number of infective (and total number) of large round worm eggs in soil or bedding material

	Infective eggs/g dry material (total eggs/g dry material)		
	Sows and piglets	Starter pigs	Fatteners
Pasture			
Farrowing	0.7 (1.0)	-	-
Weaning	-	2.3 (8.5)	-
Pen area			
Resting (clean)	-	0.7 (73)	1.4 (135)
Intermediate	-	6.8 (326)	6.3 (555)
Latrine (very soiled)	-	9.2 (1732)	2.6 (1033)

eggs on the farrowing pastures. Most farms had semi-permanent pastures. Rotation schemes of 1-3 years being too short to allow for natural mortality to ensure "clean" pastures. Especially paddocks for weaned and fattening pigs should be considered a hazard. This is due to the high prevalences, egg excretion rates and stocking rates in these age groups. One study at the university farm indicated that maximum pasture infectivity is reached 2-3 years after contamination. Ploughing of the pastures did not seem to be able to reduce infection levels in pigs.

Apart from long-term (e.g. min 5 years) rotation schemes, there are currently no ways to sufficiently inactivate eggs in the soil. In highly infected herds it may be necessary to treat pigs when they are moved to the stable.

Stables

Only a very small proportion of the large round worm eggs in the bedding material were infective to pigs (Table 1). Still, as there were millions of eggs, enough were infective for the pigs to be continuously exposed. So much so that 87% of the fatteners was positive for liver white spots (due to migrating larvae) at the abattoir. Bedding material may help parasite eggs to survive, but the amount of litter appeared to be less important. The project could not confirm previous suggestion that deep litter deep litter is particularly problematic.

Parasite eggs were found not just on the pen floor, but also on walls and inventory. The results also indicated that sprinklers placed close to areas with straw and manure



Experimental manure heaps to study the effect of composting on large round worm eggs.

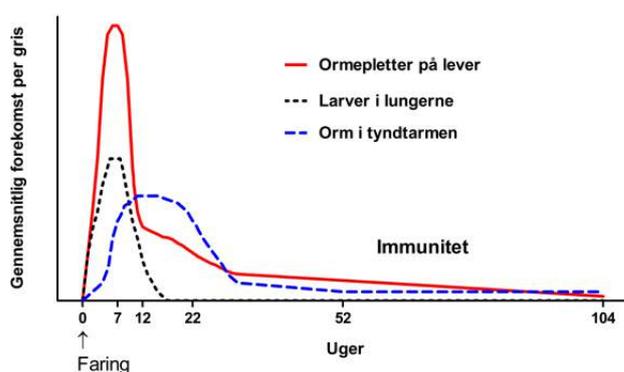


Figure 1. Generalized model illustrating large round worm infection levels over time. When an egg is ingested, a larva hatches in the intestine and migrates to the liver, lungs and back to the intestine.

may dilute urine and faeces. This may reduce the negative impact of ammonia and improve egg survival and development.

Lack of cleaning between batches of pigs was identified as a risk factor. Ideally all manure and straw should be removed and pens washed 1-2 times a year. The pens should then be allowed to dry out, preferably using a gas burner, as heat kills the eggs. Even small amounts of faeces and straw severely reduced the effect of disinfectants.

Composting

For all five farms it was estimated that 81 % of the eggs were dead due to unfavourable conditions (high ammonia, high temperature and/or low humidity) in the litter. The remaining eggs were still viable and millions of eggs could potentially develop if ploughed into the soil with the manure.

The project therefore examined composting of straw with solid manure. The outcome was that if the material is too hot touch (700C) the eggs will be dead. Alternatively, composting at 500C for up to one week will also kill the eggs. At 250C, slurry should be stored for one year, but at lower temperatures this is not enough to inactivate all the eggs.

Monitoring

To determine a herd's parasite status, faecal samples should be examined. This should be done for 10 starter pigs, 10 large fattener pigs and 10 sows. This will give a good overview before determining if control measures are needed and where.

Organic diets are equally good for rainbow trout fry as conventional diets

With respect to rainbow trout, the OPTIFISH project has shown that feed composition is more important than whether the feed is of organic or conventional origin.

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Rainbow trout (*Oncorhynchus mykiss*) is the dominant fish species in Danish freshwater aquaculture and the annual production is about 30.000 tonnes. Only a minor part of this production is organic, but the proportion of farmed organic rainbow trout is continuously increasing. The aim of the project OPTIFISH has been to elucidate the effect of diet ingredients on fish health. Diets with either organic or non-organic ingredients were compared. The OPTIFISH project has shown that the ingredient type in the diet is more important for the bacterial intestinal microbiota of the fish than if the diet ingredients are of organic or conventional origin. Furthermore, fish fed organic diets appear to acquire the same health status as fish fed conventional diets.

OPTIFISH has become even more relevant for the aquaculture industry since a new EU Resolution (710/2009) requires that organic fish as from 2016 shall be 100 percent based on organic rainbow trout fry. The current requirement is that to be labelled organic, fish need only to be fed organic as from a weight of 25 g. In the future stricter regime, fish can only be sold with the organic label if they have been raised under organic measures throughout the production period and have been fed with diets approved for organic aquaculture.

The background for the OPTIFISH project

To maintain its organic label, a fish may only be treated with antibiotics a limited number of times. Repeat-

ed outbreaks of Rainbow Trout Fry Syndrome (RTFS), caused by the bacterium *Flavobacterium psychrophilum*, increase the requirement for treatment and therefore increase the risk to the producer of losing the organic label. The main challenge is to avoid diseases. Disease prevention might be achieved with a diet, which strengthen the immune system and thereby reduces the risk of disease. Furthermore, it is known from salmon aquaculture that plant protein ingredients (e.g. soy meal) in the diet can affect the intestinal mucosa and increase the risk of infections that weaken the immune status of the fish. OPTIFISH focused on how organic diets with different levels of marine and plant ingredients, with or without probiotics, affect the intestine of the fish, the bacterial intestinal microbio-

ta as well as the survival of the fish in connection with infections.

Diet experiments

The overall study was organized into two large feed experiments, in which groups of rainbow trout were fed with different diet types from first feeding till an average weight of 8 g. During Experiment I conventional marine diet types were compared with plant diets containing both rape seed oil and pea protein. The plant diets were shown to have a positive influence on the composition of the intestinal bacterial microbiota (higher amount of lactic acid bacteria) among the fish, but we did not determine whether this was due to the addition of rape seed oil or pea protein. Therefore, rape seed oil, pea protein or both ingredients were included in the diets tested in Experiment II (Table 1). The probiotic bacteria (approved for adding to fish feed) used in Experiment I did not have any clear effect in the tested dose and experimental design, neither on the composition of the intestinal



Rainbow trout is the dominant fish species in Danish freshwater aquaculture. Photo: BioMar A/S

Table 1. The composition of the diet types investigated in Experiment II.

	A	B	C	D	E
Fish meal	x				
Fish meal, trimmings *		x	x	x	x
Krill meal (MSC certified)	x				
Hydrolysed fish protein	x				
Pea protein				x	x
Wheat gluten	x				
Organic wheat gluten		x	x	x	x
Wheat flour	x				
Organic wheat flour		x	x	x	x
Fish oil	x				
Fish oil (wild and/or trimmings)*		x		x	
Organic rape seed oil			x		x
Premix	x				
Organic premix		x	x	x	x
Probiotics	x	x	x	x	x

*=Approved for diets for organic fish

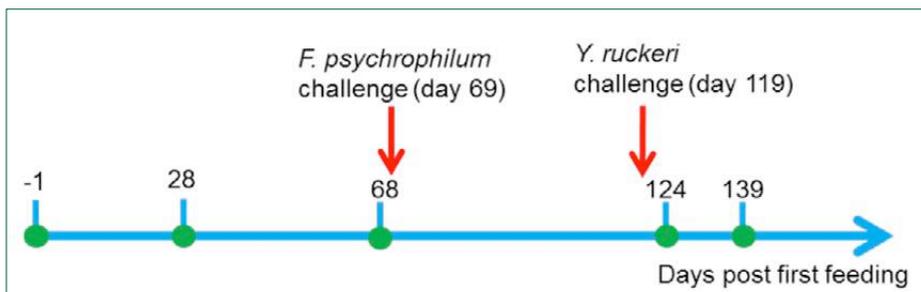


Figure 1. The samplings done during Experiment II. Experimental infections with either *Flavobacterium psychrophilum* or *Yersinia ruckeri* were done day 69 and 119, respectively, after first feeding.



Only a minor part of the production of rainbow trout in Denmark is organic, but the proportion of farmed organic rainbow trout is continuously increasing. Photo: Fiskehuset Thisted Aps.

bacterial microbiota nor in connection with experimental infection with bacterial fish pathogens. Since the probiotic is added as a standard in diet type A (the commercially sold fry diet Inicio Plus), it was added to all diets in Experiment II.

During the experiments, samples were collected to conduct a molecular investigation of the intestinal bacterial microbiota composition and to investigate the immune response in fry (Figure 1). Additionally, during both experiments sub-groups of fish from each treatment group were subjected to experimental infections with two pathogenic bacteria to investigate the effects of diet composition and organic origin on the progress of infection. Figure 1 shows a timeline of sampling and experimental challenges done during Experiment II.

Concerning Experiment II, in the first experimental infection experiment 1.5 g fish were injected in the peritoneal cavity with *Flavobacterium psychrophilum*. The cumulative mortality was between 82 and 92 % in the different groups. The lowest mortality was seen for fish fed diet type B. In the second experimental infection, 4 g fish were bathed in a solution of the bacterium *Yersinia ruckeri*, the cause of enteric redmouth disease. The mortality among all treatment groups ranged from 53 to 61 %. There were no statistical differences among the mortalities in the diet groups in either infection experiment.

Beneficial bacteria in the feed

Another task in the project OPTIFISH was to study how probiotic bacteria added to the diet influenced the composition of the intestinal bacterial microbiota and the health of the rainbow trout fry. Probiotic bacteria have been suggested to work in different ways. One of the mechanisms of action suggested is that growth and colonisation with probiotic bacteria may create a layer on the surface of the intestine, preventing the entry of undesirable bacteria into the host tissue. Another hypothesis is that the presence of probiotic bacteria may inhibit the growth of undesirable, pathogenic bacteria due to the production of inhibitory substances like bacteriocins and lactic acid leading to decreased pH in the intestine.

OPTIFISH examined whether addition of probiotic bacteria to the fish feed influenced the immune system and survival of the fish after challenge with the pathogenic bacteria *Flavobacterium psychrophilum* or *Yersinia ruckeri*. No effect of the probiotic

Diets produced of marine/plant ingredients

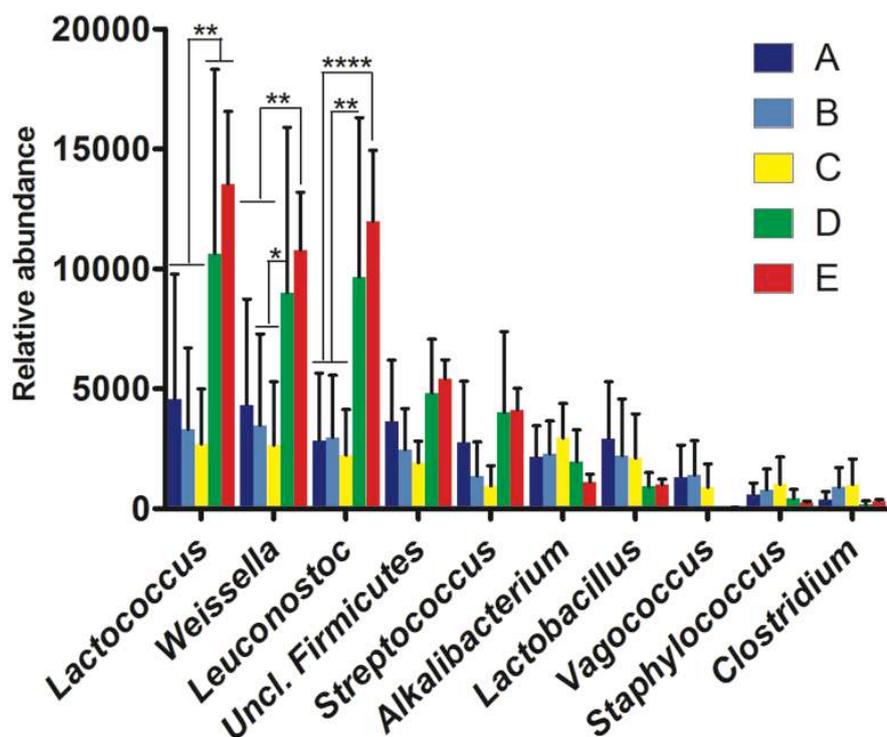


Figure 2. The ten most abundant bacterial taxa on day 28 after first feeding for each of the five investigated diet types (A-E) in Experiment II.

was shown in this work with the used dosage and experimental design. Instead it seemed that the effect was much higher between diet types with differences in oil and protein contents as well as origin of the ingredients.

The results from Experiment I suggested a large influence on the intestinal bacterial microbiota in fish that had been fed the diet with pea protein and plant oil in comparison to fish fed the marine diet. Therefore Experiment II focused on diets that only varied with one ingredient. It was shown that the addition of pea protein (diet types D and E) seemed to be more important than the oil (Figure 2). This is a very relevant observation, and the results can be used in future design of fry feed (both organic and conventional diets). An increased occurrence of *Lactococcus* as seen for diet types D and E is desirable because of its well-known probiotic properties.

Results of the investigation of immunological parameters of intestinal samples from the fish showed that there was a high level of expression of innate immune genes, but there was no difference in this response in fish from the different diet groups.

Bacterial infections were also shown to have a high influence on the composition of the intestinal bacterial microbiota, and especially in Experiment II it was shown that the major part of the intestinal flora in the infected fish

consisted of the pathogenic bacterium *Yersinia ruckeri*.

The feed ingredients are most important

The OPTIFISH project has shown that the composition of the diet is more important for the gut microbiota of the fish than whether the diet is of organic or conventional origin. There was a clear difference of the intestinal microbiota with diets containing pea protein, whereas the origin of the added oil (marine versus plant) seemed to be less important. Experimental infections showed that the diet type did not affect fish survival. Therefore

the investigated diets are believed to have the same effect on the fish health, according to the results on the parameters that we decided to investigate during the OPTIFISH project. According to OPTIFISH, organic diets for commercial use will lead to the same health status in fish as conventional diets. It has to be stressed that survival as a parameter for evaluating infection is quite a "rough" method to use. Therefore the project could not rule out that differences in the composition of the gut microbiota between the fish from the different diet groups might have had a minor, not "readable" influence on fish health.

OPTIFISH was a collaboration between universities and private companies. The project was headed by the National Veterinary Institute at DTU and the other partners were Faculty of Health and Medical Sciences, University of Copenhagen, BioMar A/S and Dansk Akvakultur (Danish Aquaculture Organization).

For more information read about the Organic RDD project OPTIFISH on the website: http://www.icrofs.dk/Sider/Forskning/organicrdd_optifish.html

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- 3) BioMar A/S
- 4) Dansk Akvakultur (Danish Aquaculture Organization)



A new EU resolution requires that organic fish must be 100 percent based on organic rainbow trout fry. Photo: OPTIFISH

Coming events

Annual conference of Bioforsk

Hamar, Norway, 4.-5. februar 2015

The annual conference of Bioforsk, the Norwegian Institute for Agricultural and Environmental Research, is this year highlighting the impact of Norwegian research in agriculture and environment on society and the value of eco-system services. Food security and climate issues are also on the agenda.

Read more: www.bioforsk.no/bfk

BIOFACH

Nuremberg, 11-14 February 2015

BIOFACH is the World's leading Trade Fair for Organic Food. The organic trade meets at the organic exhibition from 11-14 February 2015 in the Exhibition Centre Nuremberg. It is the place where people share their passionate interest in organic food, get to know each other and exchange views. As a visiting professional you can meet organic producers from the international organic market and be inspired by the sector's latest international trends. BIOFACH expects about 42.000 visitors in 2015.

Read more: <https://www.biofach.de/en/>

BIOFACH2015

into organic

European Geosciences Union: General Assembly 2015

Vienna, Austria, 12-17 April 2015

Organic soil management in different countries is one of many topics on the agenda at the EGU General Assembly in 2015. The EGU aims to provide a forum where geoscientists, especially early career researchers, can present their work and discuss their ideas with experts in all fields of geoscience.

Read more: <http://www.egu2015.eu/>

The INNOHORT symposium

Avignon, France, 8-12 June 2015

The INNOHORT symposium - International Symposium on Innovation in Integrated and Organic Horticulture is organized by The international Society of Horticulture and

aims at bringing together researchers from a wide horizon, willing to share their views and knowledge to design the integrated and organic horticultural cropping systems of tomorrow. One ambition of this symposium is to examine to what extent gaps can be bridged between scientists from different backgrounds, between researchers and stakeholders, between research and action.

Deadline for Abstract submission is 31 January 2015

Read more <https://colloque.inra.fr/innohort2015>

International Conference on Research in Biodynamic Agriculture University of Padova, Conegliano, Italy 27-30 August 2015

The first international conference ever on research in Biodynamic Agriculture will take place in Italy in August 2015. The conference aims to be a forum for presentation of new advances and research result in the field of biodynamic agriculture, and bring to together leading academic scientists, researchers and scholars from all over the world.

Read more: <http://icoriba.org/>

3rd African Organic Conference

Nigeria, 5-9 October 2015

Theme: "Achieving Social and Economic Development through Ecological and Organic Agriculture Alternatives". Submission deadline for papers is end of March 2015, via Organic Eprints

Read more: <http://www.icrofs.org/pdf/2014/3rd%20AOC%20final.pdf>

ICOAS 2015, Bratislava, 14-17 October 2015

The 5th international conference on scientific research in organic agriculture located in Eastern Europe takes place in the capital of Slovakia, Bratislava, and the 14 - 17 October. Innovation is the over-arching theme of the conference. Bringing innovations to organic farming"

Read more: <http://www.icoas2015.org/>



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