Danish Research Centre for
Organic Food and Farming

Progress Report 2008 and Application for Continuation in 2009

for research funding under the research programme:

Research in Organic Food and Farming
International Research Co-operation and Organic Integrity
(DARCOF III 2005-2010)

Funded by the Ministry of Food, Agriculture and Fisheries
under the Finance and Appropriation Act, Sections 24.33.02.10

1. Project title and acronym

The effect of cropping systems on production and the environment (CROPSYS)

2. Project journal number

3304-FOJO-05-04-01

3. Project period (month, year)

Start of project: January 2006
End of project: June 2010

4. Head of project

Jørgen E. Olesen, research professor
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
P.O. Box 50, 8830 Tjele
Tel: (+45) 89991659, Fax: (+45) 89991619
E-mail: JorgenE.Olesen@agrsci.dk

5. Participating institutes

University of Aarhus, Faculty of Agricultural Sciences (DJF) **[P1]**
Department of Agroecology and Environment

Research Centre Foulum, P.O. Box 50
DK-8830 Tjele
Tel. (+45) 89991900, Fax. (+45) 89991919
E-mail: djf@agrsci.dk

University of Aarhus, Faculty of Agricultural Sciences (DJF) **[P2]**
Department of Integrated Pest Management
Research Centre Flakkebjerg
DK-4200 Slagelse
Tel. (+45) 89991900, Fax. (+45) 89993501
E-mail: djf@agrsci.dk

University of Aarhus, Faculty of Agricultural Sciences (DJF) **[P3]**
Department of Genetics and Biotechnology
Research Centre Foulum, P.O. Box 50
DK-8830 Tjele
Tel. (+45) 89991900, Fax. (+45) 89991919
E-mail: djf@agrsci.dk

Risø National Laboratory (Risø) **[P4]**
P.O. Box 49
DK-4000 Roskilde
Tel. (+45) 46774677, Fax. (+45) 46775688
E-mail: risoe@risoe.dk

Copenhagen University (KU) **[P5]**
Biological Institute
Universitetsparken 15
2100 København Ø
Tel. (+45) 35321274, Fax. (+45) 35321300
E-mail: lkjonsson@bi.ku.dk

---

6. Project staff

Research professor Jørgen E. Olesen
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991659
Fax. (+45) 89991619
E-mail: JorgenE.Olesen@agrsci.dk

Senior scientist Ilse A. Rasmussen
University of Aarhus, Faculty of Agricultural Sciences
Department of Integrated Pest Management
Research Centre Flakkebjerg
DK-4200 Slagelse
Tel. (+45) 89993594
Fax. (+45) 89993501
E-mail: IlseA.Rasmussen@agrsci.dk

Senior scientist Kristian Kristensen
University of Aarhus, Faculty of Agricultural Sciences
Department of Genetics and Biotechnology
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991209
Fax. (+45) 89991300
E-mail: Kristian.Kristensen@agrsci.dk

Senior scientist Per Ambus
Risø National Laboratory
Biosystems Department
P.O. Box 49
DK-4000 Roskilde
Tel. (+45) 46774152
Fax. (+45) 46774160
E-mail: per.ambus@risoe.dk

Professor Søren Christensen
Copenhagen University
Biological Institute, Terrrestrial Ecology
Universitetsparken 15
DK-2100 København
Tel. (+45) 35321274
Fax. (+45) 35321250
E-mail: schristensen@bi.ku.dk

Senior scientist Margrethe Askegaard
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991702
Fax. (+45) 89991619
E-mail: Margrethe.Askegaard@agrsci.dk

Senior scientist Per Schjønning
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991766
Fax. (+45) 89991619
E-mail: Per.Schjonning@agrsci.dk

Senior scientist Søren O. Petersen
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991723
Fax. (+45) 89991619
E-mail: Soren.O.Petersen@agrsci.dk

Senior scientist Lisbeth Mogensen
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991223

Fax. (+45) 89991619
E-mail: Lisbeth.Mogensen@agrsci.dk

Scientist Mette Lægdsmand
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991767
Fax. (+45) 89991619
E-mail: Mette.Laegdsmand@agrsci.dk

PhD student Ngonidzashe Chirinda
University of Aarhus, Faculty of Agricultural Sciences
Department of Agroecology and Environment
Research Centre Foulum, P.O. Box 50,
DK-8830 Tjele, Denmark
Tel. (+45) 89991767
Fax. (+45) 89991619
E-mail: Ngonidzashe.Chirinda @agrsci.dk

---

7. Midterm description of the project, its results and progress, and application for continuation in 2009

A. Project summary

Modern agricultural systems greatly influence the environment, and there is a particular emphasis in Denmark on nitrate leaching and greenhouse gas emissions from agriculture. Sustainable agricultural systems also need to fulfil the requirements for quantity and quality of the agricultural produce. Crop production in organic farming systems relies to a large extent on soil fertility for nutrient supply. The soil fertility must be maintained via choice of crop rotation and (green) manuring practices. A proper management of this to improve crop yields and reduce emissions to the environment requires an in-depth understanding of soil processes and nutrient dynamics, and their effects on crops and weeds.

A long-term organic crop rotation (CRO) experiment was initiated in 1997 at three different locations in Denmark; in 2005 it is modified to include also a conventional system. The three locations represent typical soils (sand, loamy sand and sandy loam) and climates for Danish agriculture. The design of the currently 8-year old rotations allows for effects of manure application and catch crops to be distinguished, and for effects of soil type and climate to be quantified. Thus, a differentiated analysis of management strategies can be conducted. The project will exploit this unique long-term experiment for an integrated study of the productivity and nitrogen (N) flows in organic cropping systems.

The project will quantify productivity and environmental impacts of different organic and conventional cropping systems across a range of soil and climatic conditions, and identify management measures, which contribute significantly to a sustainable development of the individual cropping systems. This will be achieved through an integrated experimental and modelling programme, where measurements of key indicators of productivity and environmental impact and of the underlying processes and dynamic soil properties are carried out in the CRO experiment. A simulation model (FASSET) and a life cycle analysis (LCA) model will be used to analyse different management scenarios. The output of the work is guidelines for improving the sustainable development of organic crop production systems in Denmark.

WP1 will coordinate the project and ensure the communication between partners and with stakeholders. A common measurement and management protocol for the CRO experiment will be maintained. All data from the CRO experiment will be stored in a database for access by all partners.

WP2 will manage the CRO experiment. The experiment includes three 4-year crop rotations representing an organic green manure/cash crop rotation, an organic cash crop rotation and a conven-

tional cash crop rotation. A factorial design is used, which includes two manure treatments and two catch crops treatments. With two replicate plots for each system combination, a total of 64 field plots are managed at each site. Crop yield and biomass of crops and weeds will be measured. The crop N uptake will be measured and the N_2-fixation will be measured in legume crops and catch crops.

WP3 will measure nitrate leaching of all cropping systems of the CRO experiment. This enables an interpretation of short- and long-term effects of management and location on the nitrate leaching. The leaching of dissolved organic nitrogen (DON) will be measured in a campaign coordinated with measurements of topsoil DON in WP5. The potential uptake of N by roots in soil layers below the installed suction cups will be analysed from measurements of root development using minirhizotrons and modelling (WP6).

WP4 will measure nitrous oxide emissions from four selected treatments in the CRO experiment during a 12 month period at two of the locations. Samples of the topsoil will be taken at the sandy loam site to investigate cropping systems effects on denitrification and the ratio of N_2O:N_2 production. Soil samples will be collected in autumn 2008 at two depths for measurements of total carbon (C) and N to analyse trends in soil C and N storage.

WP5 will quantify the effects of contrasting cropping systems on a range of soil attributes (including pore size distribution, air permeability, soil workability, soil mineral N, DON, microbial biomass N). Measurements will be taken during two years in the CRO experiment. Some of the measurements will be taken in all systems. However, the majority of the effort will focus on the four contrasting systems and the two sites also used in WP4. In addition, soil samples will be analysed for net N mineralisation and for microbial biomass pools.

WP6 will use statistical methods, simulation modelling (FASSET) and life cycle analyses (LCA) to generalise the results of the CRO experiment (WP2 to WP5) to other climatic and soil conditions and to other management strategies. This will include an assessment of the environmental impact of the whole product chain for both organic and conventional farming systems. These results will be used for quantifying management measures that may contribute significantly to a sustainable development of organic farming systems.

Table A.1: Work package list (from application)

WP No.	WP title	Responsible scientist	Budget DKK	Start	End	Deliverables
1	Project management and communication	JEO	632,200	2006-01	2010-06	D1.1-D1.5
2	Productivity of cropping systems	MAS	7,923,571	2006-01	2009-12	D2.1-D2.4
3	N leaching losses	MAS	2,737,905	2006-01	2009-12	D3.1-D3.3
4	Greenhouse gases and denitrification	SOP	2,142,529	2007-01	2009-12	D4.1-D4.3
5	Soil quality	PSC	2,702,913	2007-01	2009-12	D5.1-D5.3
6	Scenario analyses and synthesis	JEO	1,723,090	2008-10	2010-06	D6.1-D6.5
Total			17,862,209			

B. Objectives and expected achievements

The overall goal is to quantify productivity and environmental impacts of different organic and conventional cropping systems across a range of soil and climatic conditions, and to identify management measures which contribute significantly to a sustainable development of the individual cropping systems. The basic hypothesis is that organic cropping systems can be maintained with high productivity at low environmental impact through better crop rotation design and management, as modified by soil type and climate. This will be achieved through a better description of the role of soil N dynamics, soil properties and crop and weed dynamics in the different systems, and using modelling and scenario analyses to integrate and evaluate production-related and environmental indicators of sustainability.

C. Midterm results and progress

C.1 Description (summary) of main results and conclusions for each year

WP1. Project management and communication

Within the project group the management has focused on ensuring that all measurements and samplings within the crop rotation experiment could be done without interfering with each other. There are many associated projects using the crop rotation experiment, and all these have some sort of special requirements either in terms of space for sampling/measurements or requirements for crop products. The requirements have been specified in protocols that are incorporated into the CROPSYS project manual, which is revised every year. The coordination of various measurement activities are also treated in detail during the annual winter and summer meetings, where all project partners of both CROPSYS and the associated projects are invited to participate.

The crop rotation experiment was changed in 2005 to also include conventional crop management treatments in addition to the organic treatments. This has posed many challenges to the technical staff in terms of proper management of the conventional treatments, which require other types of attention than the organic treatments. Especially the crop protection issues has been a challenge and we therefore invited a specialist from the Danish Agricultural Advisory Service to participate in the winter meeting in 2007 to discuss in detail the guidelines for proper conventional crop protection for the crops grown in the conventional treatments.

In June 2006 the project organised a seminar at Research Centre Foulum on "Production and environmental impacts in organic farming". The seminar included presentations and discussions in the auditorium at Research Centre Foulum followed by a visit to the field trial at Foulumgård. There was a good and lively discussion at the seminar and summaries of the presentations and discussions are available from the okoforsk website.

In June 2008 a meeting was held with the projects stakeholder group, which consists of representatives from Ministry of Food, Agriculture and Fisheries, the green NGOs, the Danish organic farming movement, organic agricultural advisors, and organic farmers. Preliminary results were presented and discussed, and the stakeholder group was subsequently asked to reflect on the future of the CROPSYS long-term experiment. The stakeholder group considered it very important to maintain and continue these experiments, including a comparison with conventional farming, although the most important is to continue comparison of different organic systems, in particular to assess long-term effects of various cropping systems. The advisory group made suggestions for changes to the systems and for dealing with some of the challenges in the organic systems, including control of perennial weeds. The CROPSYS project group will take account of this advice during consideration of the future of the experiments.

WP2. Production of cropping systems

Measurements of yield (task 2.2), weed (task 2.3), nitrogen uptake and N_2 fixation (task 2.4) were carried out at all locations. Table 1 show the dry matter (DM) yields of spring barley, winter wheat, faba bean and potato tubes in the three crop rotations with the different combinations of fertilizer application and catch crop use. In spring barley with fertilizer and catch crops we obtained similar high grain yields in the conventional and organic treatments at Jyndevad and Foulum. This was not the case in winter wheat where the yields were significantly lower in the organic treatments. There was positive effect of catch crops on the organic barley yields at Jyndevad and Foulum, highest in the O4-rotation with no grass-clover green manure crop.

The organic crops responded positive to manure application, most in the O4-rotations with no grass-clover green manure crop and at Jyndevad. Also the organic faba beans responded positive to the manure treatment of the other crops in the O4 crop rotation. Like in 2006 this indicates that nutrients other than N and K (applied in vinasse) had been yield limiting.

The grass-clover in O2 was in 2007 cut four times at Jyndevad and three times at Foulum and Flakkebjerg. In the two treatments with manure application the cuts were removed and in total about 317, 246 and 389 kg N ha^{-1} was harvested at Jyndevad, Foulum and Flakkebjerg, respectively, as an average of the two catch crop treatments. In our models this N is anaerobic digested and recycled to the fields. Thus, for distribution in 2008 the average N harvest would in the theory provide the crop rotation with 37 kg N ha^{-1} more at Jyndevad, 34 kg N ha^{-1} less at Foulum and 107 kg ha^{-1} more at Flakkebjerg compared with the planned 280 kg N ha^{-1}. However, at Jyndevad there was significant difference in the N-productivity between the two catch crop treatments. Thus, the N yield was 400 kg ha^{-1} in the treatment without catch crops and only 230 kg ha^{-1} in the treatment with catch crop.

Table 1. Grain, seed and tuber yields in 2007 (t DM ha^{-1}).

		Crop	Spring barley			Winter wheat			Faba bean			Potato		
			Location											
Crop rotation	Fertilizer	Catch crop	JY	FO	FL	JY	FO	FL	JY	FO	FL	JY	FO	FL
			t DM ha^{-1}									Kg DM ha^{-1}		
O2	-	+	3.54	4.11	2.43	*(0.23)*	2.53	2.43				4.98	4.96	5.40
	+	-	3.97	4.01	3.45	0.90	4.12	3.51				5.44	5.35	5.20
	+	+	5.39	4.61	3.33	*(1.23)*	4.13	3.33				4.76	5.16	5.69
O4	-	+	2.94	3.65	2.66	0.84	1.81	1.62	1.14	2.11	2.32	5.12	5.02	4.08
	+	-	3.57	3.20	3.37	1.56	3.58	3.58	1.66	1.95	2.71	5.11	5.04	5.54
	+	+	5.07	4.64	3.79	1.62	3.42	3.05	1.44	2.18	2.84	5.41	5.20	5.35
C4	+	-	4.85	4.75	5.57	4.88	7.01	6.24	2.10	2.26	3.06	8.76	7.69	9.56
	+	+	5.26	4.54	5.15	4.54	5.90	6.28	1.66	2.06	3.44	8.54	7.27	8.86

In block two of rotation O2 the winter wheat was reseeded with spring wheat due to mis-growth.

The weed biomass measurements continues, and Figure 1 shows average results from start of the experiment to 2007. The biomass of perennial weeds has increased at all locations, most at Jyndevad and Flakkebjerg and less at Foulum where the average crop yields is highest.

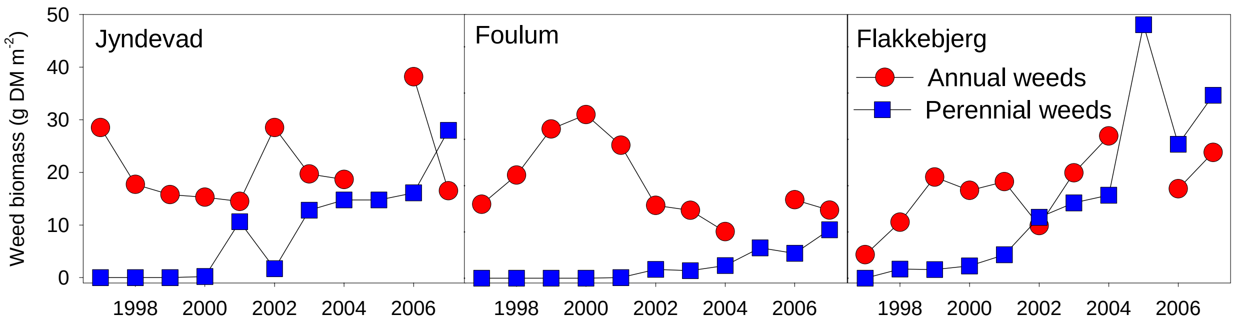


Figure 1. Biomass of annual and perennial weeds at the three locations as an average of the organic crop rotations O2 and O4 and manure treatments.

The effect of competition of perennial weeds (Elymus repens and Cirsium arvense) on the cereal and pulse crops have been studied at two locations, E. repens at Jyndevand and both E. repens and C. arvense at Flakkebjerg. Preliminary results indicate that the nutritional status (with or without manure) and the fertility of the crop rotation (with or without grass-clover) both have an influence on the effect of E.repens on yield of winter wheat at Jyndevad (Figure 2). The tendency was that at low nutritional status (without manure), the yield of winter wheat was equally low at all levels of E. repens regardless of fertility in the crop rotation. At higher nutritional status (with manure), the yield in the crop rotation without grass-clover (low fertility) decreased with increasing levels of E. repens, while this was not the case in the crop rotation with grass-clover. Unfortunately there were only very low levels of E. repens in the winter wheat the following year, due to intense and effective weed control in the potatoes the year before. The same tendency was not found in any other crops. In winter wheat at Flakkebjerg, there was a tendency for C. arvense to cause a larger decrease in yield in the systems without catch crops than in the systems with catch crops.

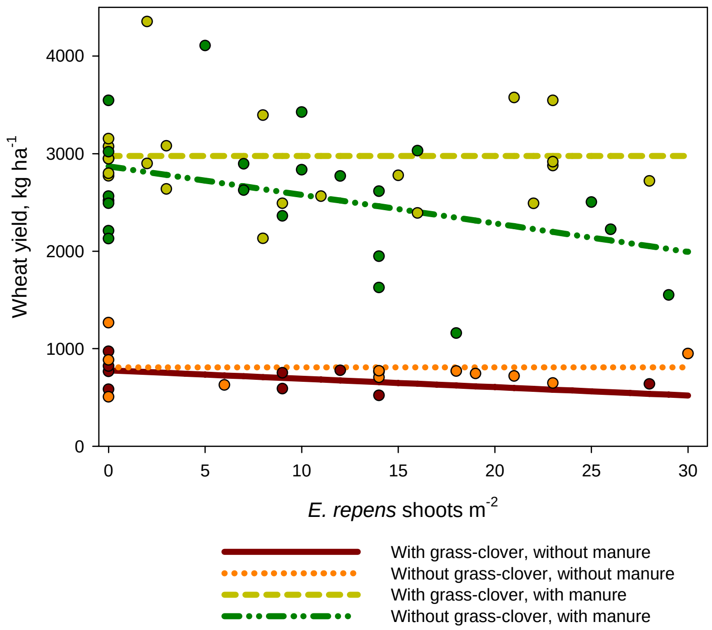


Figure 2. Winter wheat yield as affected by amount of E. repens at Jyndevad in 2006 in crop rotations with and without grass-clover and with and without catch crops.

WP3. N leaching losses

Soil water has been sampled during 2007/08 from the installed suction cups (task 3.1). Figure 3 shows an example of soil water nitrate-N concentrations in potato in one treatment at the three locations. The potatoes succeeded a grass-clover green manure. Not surprisingly there was no influence of the catch crop on the nitrate concentrations. The catch crops in this crop rotation (O2) are established two year before the potatoes. The nitrate concentrations were significantly lower at Flakkebjerg compared with the other two locations. Next year, when a full crop rotation has passed, the experimental design allows for measurements of the nitrate leaching losses from the different cropping systems.

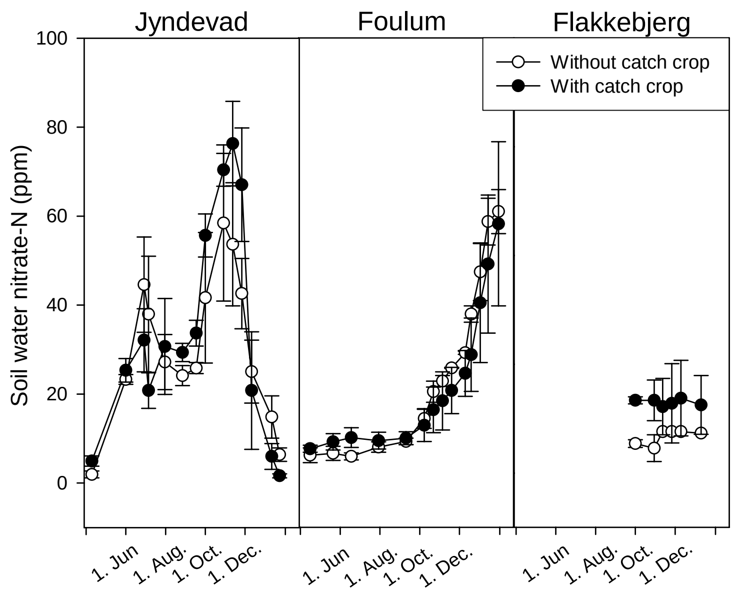


Figure 3. Nitrate-N concentrations in potato in crop rotation 2, with fertilizer, and with and without catch crop at the three locations, 2007/08 (n=2).

In 2006 and 2007 we investigated root depths and corresponding soil mineral N in different soil layers. The root development was video filmed in installed minirhizotrones, and these data are under analysis. Figure 4 shows soil mineral nitrogen concentrations measured in early November 2007 at Foulum in the investigation of root depths. The data from both Foulum and Flakkebjerg (not shown) shows significant effects on the N_{min} contents at different depths. Furthermore, it appears that the effect of catch crop type on the N_{min} content to interacts with the crop rotation due to different degree of competition from the spring barley nurse crop.

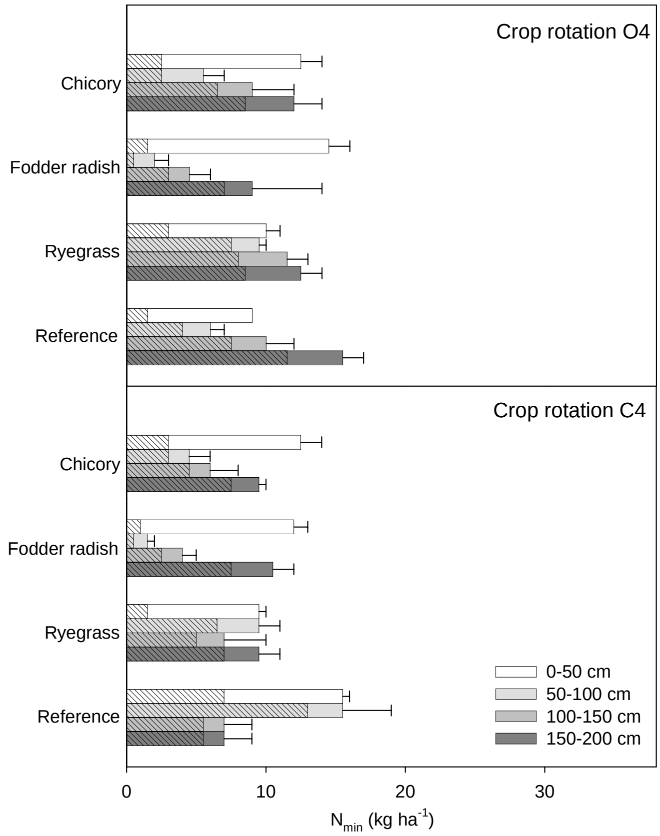


Figure 4. Mineral nitrogen (N_{min}) at different depths measured under different catch crops and a reference without catch crop at Foulum, 2007 (n=2). The hatched areas show the amount of nitrate-N.

WP4. Greenhouse gases and denitrification

Nitrous oxide emissions are influenced by soil structural properties, as well as by N and organic matter availability. Total emissions of N_2O therefore integrate several aspects of a cropping system (rotation, fertilization, return of crop residues, manure application).

By September 2008 the 12-months monitoring of N_2O emissions from four crop rotations at Flakkebjerg and Foulum was completed. Measurements were conducted in the winter wheat crop of three rotations, i.e., O2(+CC), O4(-CC), O4(+CC), all receiving pig slurry in spring, and C4(-CC), which received mineral fertilizer. The rotation O2 includes a year with grass-clover that is used as a green manure.

The accumulated area based N_2O emissions from October 2007 to August 2008 at Flakkebjerg are illustrated in Figure 5a. The preliminary examination of the data reveals no significant differences in the accumulated N_2O emission between the four rotations, but a strong tendency towards a higher N_2O emission from the conventional winter wheat than from the organic winter wheat ($P = 0.06$). Statistical analyses on the full dataset are needed to reveal other effects on the N_2O emission. However, the accumulated N_2O emissions indicate that including grass-clover as green manure in the crop rotation may lead to increased N_2O emissions from the following cash crops due to higher soil fertility. In contrast growing a catch crop following winter wheat may reduce the N_2O emission from subsequent crops.

The N_2O emissions related to the yields appear in Figure 5b. The organic crop rotation without green manure but with catch crop (O4 +CC) had the lowest N_2O emissions per produced kg of wheat, whereas the two other organic rotations emitted amounts comparable to the conventional system in terms of N_2O emission per kg wheat. Hence, the organic winter wheat tended to give rise to a lower N_2O emission per unit of land area than the conventional wheat, but when calculated per kg yield then only one of the organic crop rotations seemed to perform better than the conventional rotation.

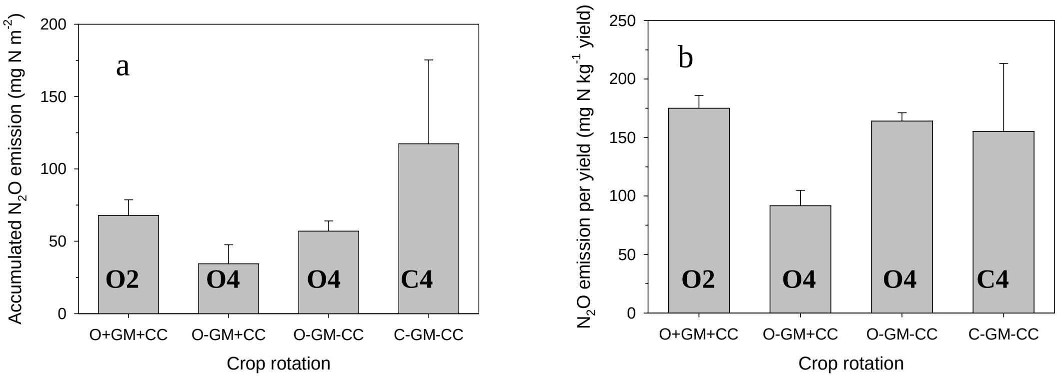


Figure 5. Accumulated N_2O emissions at Flakkebjerg from October 2007 to August 2008 in winter wheat of three organic crop rotations (O) and one conventional rotation (C) with or without green manure included in the rotation (+/-GM) and with or without catch crop following winter wheat (+/-CC); n = 4, means ± SE. Emissions are expressed per area basis (a) and per harvest yield (b).

At Foulum, the planned monitoring of N_2O emissions was extended by monitoring of N_2O emissions from two organic rotations, O2(+CC) and C4(-CC), not receiving N inputs in manure, and by monitoring of soil CO_2 fluxes from soil (separated into two components soil + root and soil only). In addition to monthly measurements of soil mineral N pools, moisture and temperature were frequently measured. At three times during the year soil quality attributes were assessed, including soil carbon and N content, microbial biomass N, potential mineralization, nitrification and denitrification. At three separate times during the cropping season, aboveground plant biomass samples were collected from both winter wheat and spring barley plots. Belowground plant biomass was determined at the flowering growth stage of both winter wheat and spring barley. The above- and below-ground plant samples were characterized for C and N content. From spring until harvest RVI was used to monitor plant growth in winter wheat plots. The supplementary information may support the interpretation of N_2O emission patterns during data analysis.

At this time the data have not yet been compiled or analyzed in detail. The time course of N_2O emissions from the six rotations included in the program at Foulum are shown in Figure 6. A general increase in autumn, during turnover of crop residues from the previous growth season, and following fertilizer application in spring is evident. The absence of the spring peak in the two rotations not receiving fertilizer N is notable.

Overall rates of N_2O at the two sites appear to be in the same order of magnitude, i.e., 1-2 kg N ha^{-1} yr^{-1}.

During autumn 2008 a screening of soil C and N in each field plot of the crop rotations at Jyndevad, Foulum and Flakkebjerg will be organized. Soil cores (*n* = 16) will be taken at random and split into 0-25 and 25-50 cm depth intervals. The pooled samples from each depth intervals will be analyzed for total N and organic C and later compared with previous registrations from 2004.

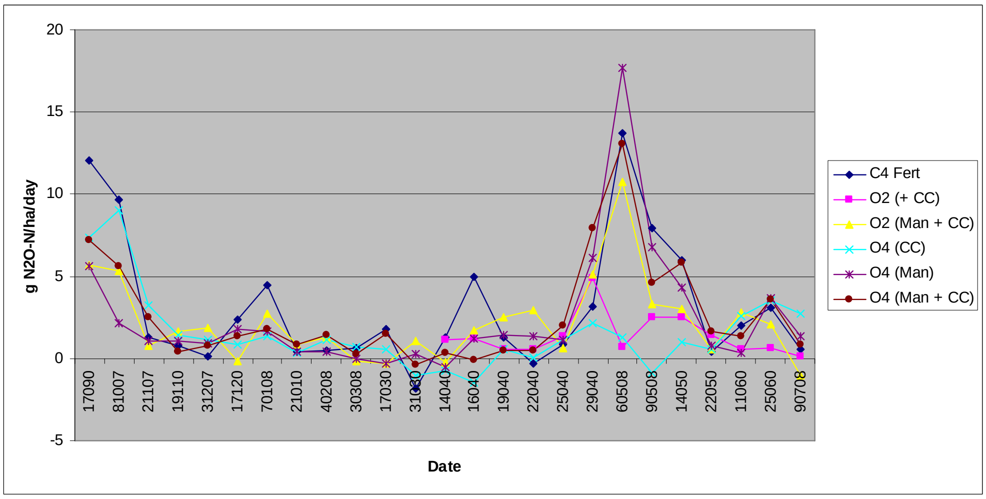


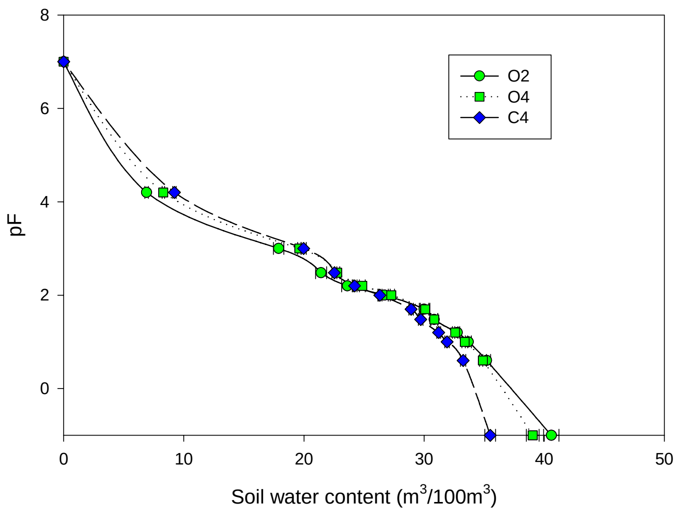
Figure 6. Nitrous oxide flux rates at Foulum between September 2007 and 2008. For explanation of treatments, see text.

WP5. Soil quality

Task 5.1 Measurements of selected soil attributes

Soil tilth properties
Intact 100 cm^3 soil cores were sampled in the spring 2007 and used for quantification of the soil water characteristic and air permeability. Other samples were tested for water-dispersible-colloids and for tensile strength of aggregates. Figure 7 indicates that the conventionally grown soil (C4) was more dense (a smaller volume of large pores) than the soil grown with the O2 and O4 rotations. This was reflected by a reduced capacity for air flow at high water contents (data not shown). The measurement programme for 2008 was exactly as for 2007, which will yield a total of four replicate plots for each treatment. The analysis of the 2008 samples is still in progress.

Figure 7. Soil water characteristic for Flak-kebjerg soil 2007, rotations O2, O4 and C4, all without catch crops but animal manure (O2 and O4) or mineral fertilizer (C4).



Nitrogen dynamics
Soil N dynamics were investigated in 2007 by sampling 250-cm^3 cylinders inserted in miniplots within the winter wheat field plots of crop rotations O2(+CC), O4(-CC), O4(+CC) and C4(-CC) early in the

growing season (November). Similar trends between rotations were observed across the three locations, whereas the temporal dynamics of mineralizable N and biomass N during the growinh season were moderate (see Figure 8). It was hypothesized that the lack of competition from plant roots stabilized these organic pools of N. This year (2008) a change in sampling strategy was therefore introduced. No sampling took place at Jyndevad, instead a sampling scheme was developed for Flakkebjerg where cylinders were inserted in November 2007 or at the time of sampling, that is, one set of soil samples had been exposed to growing plant roots until the time of sampling. Also, the long-term effects of crop rotation were emphasized by covering the soil surface to be sampled with cut plastic tubes at the time of slurry application (Fig. 9); at Flakkebjerg it was reported that the exclusion of slurry was not always successful. The results from 2008 have not been analyzed at this time.

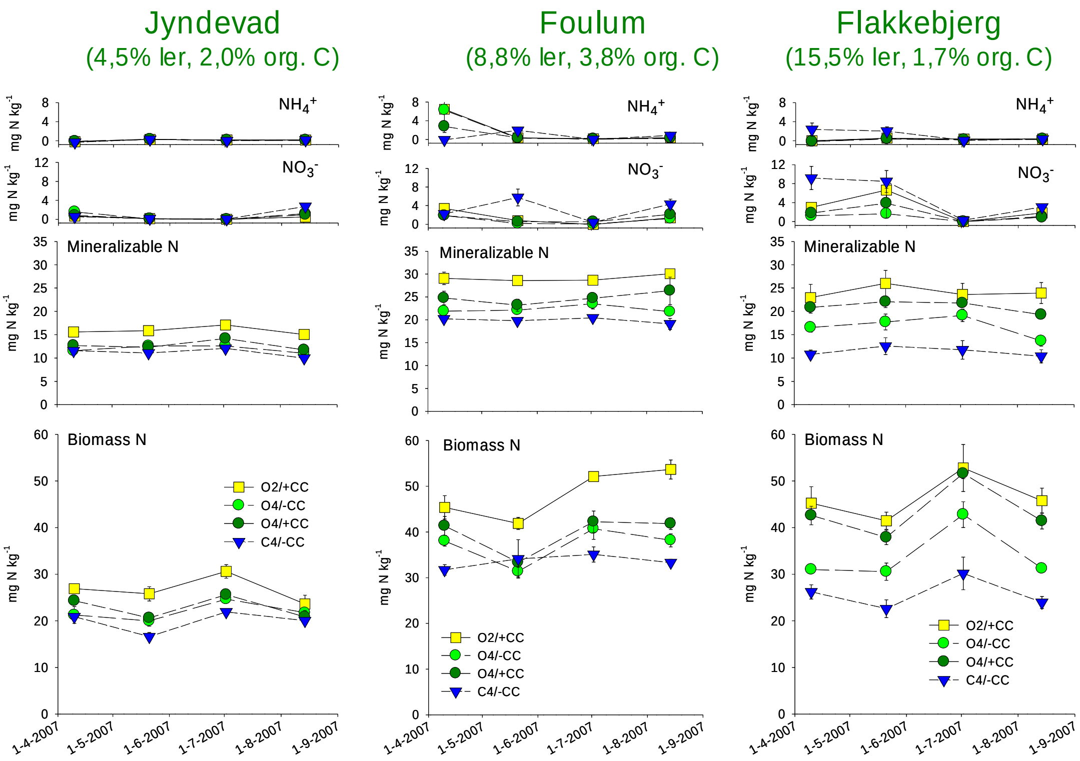


Figure 8. Soil N dynamics across the growth season in winter wheat of three organic and one conventional crop rotation.

Figure 9. The soil surface was covered during slurry application.

Task 5.2 Soil microbial biomass: distribution between bacteria and fungi

The marked differences in microbial biomass (initial respiration rate in glucose amended soil) we observed in 2007 between mineral fertilised and manured treatments apparently disappeared in 2008. Two explanations for this development can be suggested: (i) the plots investigated in 2008 are in another state (physical, chemical, biological) than the plots used in 2007, or (ii) the previously unamended plots received mineral fertiliser for the first time in spring 2005 at the start of the present experiment. During the first three cropping seasons, this fertilization possibly stimulated plant growth to give an input of plant material similar to the manured treatments supporting fast-growing microorganisms, even though soil organic matter will still be lower in fertilised compared to in manured treatments. According to our plan we will also record food preference (bacterivorous/fungivorous) for the nematodes in the 2008 samples. This is done instead of the respiration assay with different combinations of bacterial/fungal inhibitors that did not produce usable results. Finally, we also determine total bacterial/ fungal biomass by acridine orange staining + microscopy and by ergosterol measurement, respectively.

WP6. Scenario analyses and synthesis

WP6 has not started yet. However, the modelling in WP6 will be supplemented with similar activities in the EU-project NitroEurope, where the data from CROPSYS will be used for validating a range of ecosystem models. Work has started within NitroEurope to compared simulated and observed nitrous oxide emissions, and we have delivered data for this from our experiment to the NitroEurope project.

C.2 Fulfilment of deliverables and milestones

Deliverables list (from application)

Deliverable No	Deliverable title	Lead scientist	Delivery date	Allocated scientific person moths	Type of deliverable	Fulfilled (ok) or deviations (d)*
D1.1	Annual reports	JEO	200x-09	0.5	R	ok
D1.2	Common protocols for conducting the CRO experiment	JEO	2006-02	1.5	R	ok
D1.3	Field days for farmers and advisors at the field experimental sites	JEO	200x-06	0.5	O	ok
D1.4	Project web-site	JEO	2006-03	0.5	O	ok
D1.5	Papers on general results of the project in agricultural and other Danish journals	JEO	2006:2010	1.0	P	ok
D2.1	Refereed paper on crop yields as affected by crop rotation, nutrient application, catch crops and site	JEO	2009-12	6.0	S	
D2.2	Refereed paper on weed propagation in different organic cropping systems	IAR	2009-12	6.0	S	
D2.3	Refereed paper on the yield – weed – nitrogen dynamics in different organic cropping systems	MAS	2009-12	6.0	S	
D2.4	Papers for farmer journals on crop production in organic farming systems	IAR	2009-06	1.0	P	
D3.1	Refereed paper on nitrate leaching as affected by crop rotation, nutrient application, catch crops and site	MAS	2009-10	5.0	S	
D3.2	Refereed paper on N flows and losses in legume based cropping systems	MAS	2009-12	5.0	S	
D3.3	Papers for farmer journals on N leaching from organic and conventional cropping systems	MAS	2009-12	1.0	S	
D4.1	Refereed paper on N_2O monitoring program	PAM	2009-12	5.0	S	
D4.2	Refereed paper on laboratory study of N_2O and denitrification	SOP	2008-12	5.0	S	
D4.3	Paper for farmers and advisors on soil C/N pools as influenced by crop rotation and management	SOP	2009-12	1.0	P	
D5.1	Refereed paper on the effect of cropping systems on soil quality attributes	PSC	2009-08	10.0	S	
D5.2	Refereed paper on the structure and function of organism groups responsible for N-mineralization	SCH	2009-10	8.1	S	
D5.3	Paper for farmers on effect of cropping systems on soil quality	PSC	2009-11	1.0	P	
D6.1	Refereed paper on validation and scenario analysis with the FASSET model	JBE	2009-12	5.0	S	
D6.2	Refereed paper on the LCA of organic and conventional crop farms	NHA	2009-12	5.0	S	
D6.3	Refereed paper on the link between soil functioning and indicators	JEO	2010-03	5.0	S	
D6.4	Refereed paper on management effects on sustainability indicators	JEO	2010-07	6.0	S	
D6.5	Papers for Danish journals on improved guidelines for organic crop production systems in Denmark	JEO	2010-05	1.0	P	

** Deviations are to be further discussed in D*

Milestones list (from application)

Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or devia-tions (d)***
M1.1	Revised database for CRO experiment	Apr 2006	ok
M1.2	Database updated with results of previous years experimental data	Jan 200x	ok
M1.3	Meeting with all involved scientists and technicians and invited stake-holders	Jan 200x	ok
M1.4	Meeting at the CRO experiments with involved scientists and techni-cians	Jun 200x	ok
M2.1	All crop production results in the database	Jan 2009	
M2.2	The N-fixation analyses finished	Jan 2009	
M2.3	Soil analyses stored in the database	Jun 2009	
M3.1	The deep root investigation finished	Dec 2008	Ok
M3.2	All nitrate concentrations in the database	Jun 2009	
M3.3	DON concentrations in the database	Jul 2009	
M4.1	Preparation of new chamber units completed	Jun 2007	Ok
M4.2	Nitrous oxide monitoring program completed	Aug 2008	Ok
M4.3	Laboratory study completed	Dec 2007	Ok
M4.4	Analyses of soil C and N completed	Mar 2009	
M5.1	Data on soil quality attributes stored in database	Feb 2009	
M5.2	Data on microbial biomass pools stored in database	Feb 2009	
M6.1	Link between CRO experiment database and FASSET model updated	Jan 2009	
M6.2	Typical organic and conventional crop rotations defined	Jun 2009	
M6.3	Statistical analyses completed	Oct 2009	
M6.4	Project workshop to discuss management effects on sustainable devel-opment	Nov 2009	

** Deviations are to be further discussed in D*

(The nature of the deliverables must be indicated by S = publication in scientific journal with peer re-view; P = publication in journals without peer review; R = reports; C = presentation at meetings and congresses or O = other types of deliverables, e.g., prototypes, models, websites, etc.).

D. Description of deviations and subsequent adjustments of plans

WP4. Greenhouse gases and denitrification

Within WP4, the plans for *Task 2 Denitrification* were modified. The incubation study with intact soil cores adjusted to three water potentials of 2007 was not repeated as originally planned. Instead additional work on denitrification potentials under field conditions has been conducted by characterizing denitrifying enzyme activity and potential ammonium oxidation on three occasions, and by conducting a method study on sample handling.

WP5. Soil quality

E. Project publications and other products

1. Products from Organic Eprints archive

Elmholt, S.; Schjønning, P.; Munkholm, L.J. and Debosz, K. (2008) Soil management effects on aggregate stability and biological binding. *Geoderma* 144:pp. 455-467.

Holst, N.; Rasmussen, I.A. and Bastiaans, L. (2007) Field weed population dynamics: a review of model approaches and applications. *Weed Research* 47(1):pp. 1-14.**

Jørgen E., Olesen (2006) Pres på bæredygtigheden. In *Økologisk Jordbrug*, Volume 16, No 359, page pp. 6-6.

Olesen, Jørgen E.; Askegaard, Margrethe and Rasmussen, Ilse A. (2008) Sædskiftets og gødskningens betydning for udbytte i vårbyg. Paper presented at Plantemøtet 2008, Hamar, Norway, 6-7 February 2008; Published in Strand, Einar, Eds. *Plantemøtet 2008*, page pp. 80-81. Bioforsk Fokus 3 (1).

Olesen, Jørgen E. and Dalgaard, Tommy (2006) Kan økologisk jordbrug være med til at løse verdens klimaproblemer?. In *Global Økologi*, Volume 13, No 3, page pp. 14-15.

Olesen, Jørgen E.; Ilse A., Rasmussen and Margrethe, Askegaard (2008) Nitrogen use efficiency of cereals in arable organic farming. Paper presented at Cultivating the future based on science. Second Scientific Conference of the International Society of Organic Agricultural Research (ISOFAR), Modena, Italy, 16-20 June 2008; Published in Neuhoff, Daniel; Halberg, Niels; Alföldi, Thomas; Lockeretz, William; Thommen, Andreas; Rasmussen, Ilse A; Hermansen, John; Vaarst, Mette; Lueck, Lorna; Caporali, Fabio; Jensen, Henning Hogh; Migliorini, Paola and Willer, Helga, Eds. *Cultivating the future based on science. Volume 1. Organic Crop production* 1, page pp. 316-319.

Olesen, Jørgen E. and Rasmussen, Ilse A. (2007) Vårbyg giver gode udbytter i økologiske forsøg. In *Landbrugsavisen Agro*, 7. December, page 32.

Rasmussen, I. A. (2008) Kvik og tidsler i sædskifteforsøgene [Elytrigia repens (Couch grass) and Cirsium arvense (Canada thistle) in the organic crop rotation experiments]. In *Økologisk Jordbrug*, 18. April, No 407, page 12. Økologisk Landforening, Århus, DK.

Rasmussen, I.A.; Askegaard, M. and Olesen, J.E. (2007) Perennial weed control and nitrogen leaching in long-term organic crop rotation experiments for cereal production. Paper presented at 7th EWRS workshop on Physical and Cultural Weed Control, Salem, Germany, 11-14 March 2007; Published in Melander, B.; Cloutier, D. and Gerowitt, B., Eds. *Proceedings 7th EWRS sorkshop on Physical and Cultural Weed Control*, page 133.

Rasmussen, I.A.; Askegaard, M. and Olesen, J.E. (2007) Perennial weeds in organic arable farming – challenges & dilemmas. Paper presented at NJF 23rd Congress 2007 Trends and Perspectives in Agriculture, Copenhagen, Denmark, 26-29 June 2007; Published in Lund, M.; Larsen, T.U.; Thøgersen, J.O.; Christensen, S.; Børsting, C.; Plauborg, F.; Munkholm, L.J.; Olesen, J.E.; Callesen, O.; Askegaard, M.; Hansen, J.G. and Hvelplund, T., Eds. *NJF Report* 3(2), page pp. 316-317.

Rasmussen, I.A.; Bastiaans, L.; Holst, N.; Grundy, A. and Melander, B. (2007) 'All models are wrong - but some are useful' - a report from an EWRS workshop on modelling weed population dynamics. Paper presented at 14th EWRS Symposium, Hamar, Norway, 17-21 June 2007; Published in Bàrberi, P.; Bastiaans, L; Bohren, C.; Christensen, S.; Gerowitt, B.; Grundy, A.; Hatcher, P.; Kudsk, P.; Melander, B.; Rubin, B.; Streibig, J.; Tei, F.; Thompson, A. and Vurro, M., Eds. *14th EWRS Symposium 17-21 June 2007 Hamar Norway*, page 116.**

Rasmussen, I.A.; Bastiaans, L.; Holst, N.; Grundy, A. and Melander, B. (2007) Report from an EWRS workshop on modelling weed population dynamics. Paper presented at 7th EWRS workshop on Physical and Cultural Weed Control, Salem, Germany, 11-14 March 2007; Published in Melander, B.; Cloutier, D. and Gerowitt, B., Eds. *Proceedings 7th EWRS workshop on Physical and Cultural Weed Control*, page 174.**

Rasmussen, Ilse A. (2006) Rodukrudt i sædskifteforsøg [Perennial weeds in organic crop rotation experiments]. In *Økologisk Jordbrug*, 30. June, No 364, page 6. Økologisk Landsforening.

Rasmussen, Ilse A.; Askegaard, Margrethe and Olesen, Jørgen E. (2006) Sædskifteforsøg skal give nye svar [Crop rotation experiments expected to give new answers]. In *Økologisk Jordbrug*, 21. April, No 359, page 9. Økologisk Landsforening.

Rasmussen, Ilse A.; Askegaard, Margrethe and Olesen, Jørgen E. (2006) Sædskifteforsøg skifter retning [Change of direction in crop rotation experiments]. In *Økologisk Jordbrug*, 21. April, No 359, page pp. 8-9. Økologisk Landsforening.

Schjønning, P. (2008) Undgå skadelig pakning af jorden. In *Økologisk Jordbrug*, 5. September, No 415, page pp. 12-12.**

Schjønning, P. (2007) The role of soil science in optimization of soil resource management. [oral] Presentation at *NJF's 23rd Congress: Trends and Perspectives in Agriculture*, Copenhagen, June 26-29 2007.**

Schjønning, P.; Munkholm, L.J.; Elmholt, S. and Olesen, J.E. (2007) Organic matter and soil tilth in arable farming: Management makes a difference within 5-6 years. *Agriculture, Ecosytems and Environment* 122:pp. 157-172.

2. Other products (oral presentations, public meetings, field days, etc.)

The presentations and summaries of the discussion from the seminar on "Produktion og miljøbelastning i økologisk jordbrug" are available at www.okoforsk.dk.

Records of field activities from the three field sites are available at www.okologgen.dk. This provides a very good channel for communicating practical information on crop management in organic farming. However, since resources for this have been very limited, almost all entries here are from the Jyndevad site.

Several demonstrations have been given to farmers/advisors and other visiting groups at all three field trial locations.

*   25-75% financed by DARCOF
**   5-25% financed by DARCOF

F. Scientific education

The N_2O monitoring program of WP4 and the investigations of soil quality attributes related to WP4 and 5 have been core experimental activities of an on-going Ph.D. training program (N. Chirinda). The PhD study is jointly funded by CROPSYS, SOAR and KU-LIFE. The primary supervisor is John Porter from KU-LIFE and the project supervisor is Jørgen E. Olesen. The topic of the PhD study is "Influence of cropping systems on greenhouse gas emissions". This study is linked to WP4, WP5 and WP6, and will as thus include both experimental and modelling aspects.

In connection with WP4.1, SOP has provided written procedures and practical instructions of Ph.D. student Ngonidzashe Chirinda with respect to mineral N, potential denitrifying enzyme assay, potential ammonium oxidation assay, biomass N analysis, respiration measurements and nitrous oxide analyses. Field variability has been examined for assessment of soil sampling procedure.

The CROPSYS project is being used as experimental site for practical exercises within a new MSc course at Aarhus University on “Carbon Cycling and Climate Change”.

G. National and international cooperation

The CRO experiment is part of the ISOFAR Long Term Experiment network.

P1 is member of the management committee in COST action 729 on "Assessing and managing nitrogen fluxes in the atmosphere-biosphere system in Europe". The methodology and methods of measuring nitrogen fluxes in the CRO experiment will be discussed at COST729 meetings.

P4 is member of the management committee of COST action 856 on "Denitrification in agriculture, air and water pollution".

P1 and P4 participate in an integrated project called "The nitrogen cycle and its influence on the European greenhouse gas balance (NitroEurope)" under the EU FP6. The CRO experiment is part of a network of long-term experiments in this proposal, and it is used for measuring management and environmental effects on nitrogen fluxes. This will in particular supplement the measurements of nitrous oxide emissions performed in the CROPSYS project. Data from the CRO experiment will also be used for testing and improving ecosystem models within the NitroEurope project.

Data from the CROPSYS project will be used by the DARCOF-III BioConcens project for testing models for analysing production and environmental effects of bioenergy production.

The CROPSYS project will deliver crop products to the DARCOF-III ORGTRACE project for use in a study on the effect of production systems on quality and health aspects. For some of the crops this will mean that virtually all crop produce will be delivered to ORGTRACE.

Samples of wheat grain will be used for analysis of baking quality in the CORE-ORGANIC project AGTEC_Org (Agronomical and technological methods to improve organic wheat quality).

An experiment on effects of manure placement for organic potatoes has been conducted over the period 2006 to 2008 in the CRO experiment at Jyndevad and Foulum with support from "Fonden for Økologisk Jordbrug".

In the DFFE project BioMan additional measurements will be taken in the grass-clover fields to quantify the effects of use of the grass-clover for bioenergy purposes for production and N-cycling.

A study on the yield reducing effect of perennial weeds as affected by crop rotation has been conducted over the periode 2006 to 2008 in the CRO experiment at Jyndevad and Flakkebjerg with support from "Fonden for Økologisk Jordbrug".

We have delivered soil samples and associated data to a project on soil carbon balance carried out at the Justus-Liebig University in Giessen, Germany.

We have initiated a cooperation with a newly established international research project 'Soil-it-is' (www.agrsci.dk/soil-it-is/) by delivering samples from the CROPSYS Flakkebjerg location to studies on basic aspects of colloid mobilization.

The N_2O monitoring program of the Cropsys project at Foulum (winter wheat crops, red circle) is complemented by monitoring programs of another national program (BioMan) (O2, green circle) on effects of grass-clover management for energy production, and by an EU-funded monitoring program (O4, C4, blue circle) (NitroEurope). There is an on-going exchange of knowledge on system effects between partners of the different projects, and together the monitoring programs will enable a complete account of N_2O emissions from several crop rotations at the site in Foulum.

	O2	O4	C4
3rd course	S. barley:ley	S. barley^{CC}	S. barley^{CC}
2005-	Grass-clover	Pea/barley^{CC}	Pea/barley^{CC}
2008	Row crop	Row crop	Row crop
	Winter wheat^{CC}	Winter wheat^{CC}	Winter wheat^{CC}

H. Critical reflection on the project

One of the primary discussion issues in the project group has been dilemma between ensuring proper soil and crop management, and the need to ensure conditions for the measurements in both CROPSYS and the associated projects that allow effects of the farming systems to be measured and compared in equal terms and with statistical confidence. Examples are restrictions in possibilities of changing varieties or re-sowing failed crops, because of need to deliver crop products to other projects, and a decision not to lime the experiments, because this would influence the measurements of soil carbon. The possibilities for mechanical weed control has also been somewhat reduced by the need to allow for detailed measurements. These discussions have in most cases ended up in favouring the needs of the measurements and delivery of products for other studies. However, we have tried to do this with as little consequence for proper crop management as possible. This has led to a more complex management of the crop rotation experiments than we anticipated and therefore a higher workload, especially for the technicians involved with the experiments at the three locations.

The higher workload on the technicians because of more complex management has unfortunately meant that the time available for communication of the crop management through the okolog web-site has had considerably less priority. We have discussed to attract additional funding for this, but we have not had the time for doing this. We believe that this priority is the right one, since a high quality of the experiment and the associated project is necessary for ensuring useful scientific results.

None of the changes in work plan give rise to any concerns with the respect to the quality and relevance of the results obtained.

8. Budget

A. Account for any change in budgets

B. Budget for the whole project (1.000 DKK)

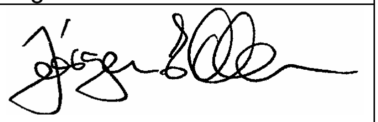
Total consumption of funds from DARCOF and expected consumption this year and coming years

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	96.6	34.7	21.0	37.0	8.1	0	101.3
Technical personnel	83.6	43.2	30.1	5.3	0.5	0	77.1

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	4770	1456	894	2140	453	0	4943
Technical personnel	2588	1217	904	335	15	0	2471
Other operational costs	1799	854	690	178	56	0	1778
Equipment	115	14	0	0	0	0	14
Others	2390	1543	792	121	0	0	2456
Direct costs	11662	5084	3280	2774	524	0	11662
Indirect costs (20% of direct costs)	2332	1017	656	555	105	0	2332
Total	13994	6101	3936	3329	629	0	13994

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project Jørgen E. Olesen	Aarhus University Faculty of Agric. Sci. Institute of	30/9 2008	

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

University of Aarhus, Faculty of Agricultural Sciences, Inst. of Agroecology and Environment

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	70.0	25.2	13.0	28.5	5.0	0	71.7
Technical personnel	46.0	22.9	17.6	4.5	0.5	0	45.5

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	3508	1059	545	1665	291	0	3560
Technical personnel	1422	631	473	307	15	0	1426
Other operational costs	1237	547	502	127	40	0	1216
Equipment	115	14	0	0	0	0	14
Others	2390	1543	792	121	0	0	2496
Direct costs	8672	3794	2312	2220	346	0	8672
Indirect costs (20% of direct costs)	1735	759	463	444	69	0	1735
Total	10407	4553	2775	2663	416	0	10407

Comments:

A. Budget for each participating institute (1.000 DKr)

University of Aarhus, Faculty of Agricultural Sciences, Inst. of Integrated Pest Management

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	8.0	2.5	1.5	3.0	1.0	0	8.0
Technical personnel	26.6	16.8	9.0	0.8	0.0	0	26.6

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	407	120	76	159	52	0	407
Technical personnel	817	502	286	28	0	0	816
Other operational costs	444	274	135	25	10	0	444
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	1667	896	498	212	62	0	1668
Indirect costs (20% of direct costs)	334	179	100	42	12	0	333
Total	2001	1076	597	254	74	0	2001

Comments:

A. Budget for each participating institute (1.000 DKr)

University of Aarhus, Faculty of Agricultural Sciences, Inst. of Genetics

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	5.0	0	0	4.0	1.0	0	5.0
Technical personnel	0.0	0	0	0.0	0.0	0	0.0

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	274	0	0	217	57	0	274
Technical personnel	0	0	0	0	0	0	0
Other operational costs	3	0	0	2	1	0	3
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	277	0	0	219	58	0	277
Indirect costs (20% of direct costs)	55	0	0	44	12	0	55
Total	332	0	0	263	69	0	332

Comments:

A. Budget for each participating institute (1.000 DKr)

Risø National Laboratory, Technical University of Denmark. Biosystems Department

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	10	4.5	4.5	0.5	0.5	0	10
Technical personnel	3	1.5	1.5	0	0	0	3

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	437	187	193	28	28	0	437
Technical personnel	109	54	55	0	0	0	109
Other operational costs	38	13	18	7	0	0	38
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	583	254	266	35	28	0	583
Indirect costs (20% of direct costs)	117	51	53	7	6	0	117
Total	700	305	319	42	34	0	700

Comments:

A. Budget for each participating institute (1.000 DKr)

University of Copenhagen, Biological Institute

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	3.6	2.5	2.0	1.0	0.6	0	6.6
Technical personnel	8.0	2.0	2.0	0.0	0.0	0	2.0

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	144	90	80	70	24	0	264
Technical personnel	240	30	90	0	0	0	120
Other operational costs	77	20	35	17	5	0	77
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	461	140	205	87	29	0	461
Indirect costs (20% of direct costs)	92	29	41	17	7	0	93
Total	554	169	246	104	35	0	554

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

University of Aarhus, Faculty of Agricultural Sciences, Inst. of Agroecology and Environment

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	12.0	4.0	4.0	4.0	0	0	12.0
Technical personnel	1.2	0.0	0.0	0.0	0	0	1.2

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	406	124	135	141	0	0	406
Technical personnel	32	0	10	11	0	0	32
Other operational costs	25	13	8	9	0	0	25
Equipment	0	0	0	0	0	0	0
Others	2221	3569	754	24	0	0	4347
Direct costs	2684	3706	908	184	0	0	4793
Indirect costs (20% of direct costs)	537	1671	182	37	0	0	1893
Total	3220	5377	1090	221	0	0	6686

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

University of Aarhus, Faculty of Agricultural Sciences, Inst. of Integrated Pest Management

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	13.7	9.7	4.0	0	0	0	13.7

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	417	289	127	0	0	0	417
Other operational costs	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	417	289	127	0	0	0	417
Indirect costs (20% of direct costs)	84	59	26	0	0	0	84
Total	500	348	152	0	0	0	500

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

University of Aarhus, Faculty of Agricultural Sciences, Inst. of Genetics

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	0	0	0	0	0	0	0

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	0	0	0	0	0	0	0
Other operational costs	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	0	0	0	0	0	0	0
Indirect costs (20% of direct costs)	82	0	0	0	65	17	82
Total	82	0	0	0	65	17	82

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

Risø National Laboratory, Technical University of Denmark. Biosystems Department

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	0	0	0	0	0	0	0

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	0	0	0	0	0	0	0
Other operational costs	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	0	0	0	0	0	0	0
Indirect costs (20% of direct costs)	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

University of Copenhagen, Biological Institute

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Man-months							
Scientific personnel	1.0	0.4	0.2	0.2	0.2	0	1.0
Technical personnel	0	0	0	0	0	0	0

Year:	Original budget	Consump-tion 2006/2007	Expected consump-tion 2008	2009	2010	2011	Total
Salaries							
Scientific personnel	55	22	11	11	11	0	55
Technical personnel	0	0	0	0	0	0	0
Other operational costs	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Direct costs	55	22	11	11	11	0	55
Indirect costs (20% of direct costs)	11	4	2	2	2	0	11
Total	66	26	13	13	13	0	66

Comments: