



## Midterm Status Report 2003 and Application for Continuation in 2004

For research projects financed by grants from  
The Directorate for Food, Fisheries and Agro Business  
under the Danish Ministry of Food, Agriculture and Fisheries

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### 1. Research program

Research in organic farming 2000-2005 (DARCOF II)

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### 2. Project title and number

I.16 Regional Groundwater Protection by Optimised Organic Farming Systems (ØKOVAND)

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### 3. Head of project

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## 6. Project period (month, year)

Start of project: April 2002

End of project: July 2005

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## 7. Midterm description of the project, its results and progress, and application for continuation in 2004

### A. Project summary

In Denmark the public gives high priority to being able to use untreated ground water for drinking. There is a growing understanding that clean ground water can only be maintained through active means. A way of regulating land use in vulnerable areas could be to use organic farming. Pesticide use will then stop. However, this does not necessarily mean a stop to nitrate leaching. Probably the loss of nitrate will differ with the type of organic cropping system used and that is the focus of this study.

Our hypothesis is that some of the management steps that characterise organic farming systems can change both the quantity and the quality of the ground water compared with conventional farming. The idea is to focus on the aspects of organic farming systems that presumably will affect the ground water. The total effect of the different management steps on ground water can only be evaluated by the use of a model that integrates the effects from the farming system. This requires that the effects of the organic farm system on the model parameters that are of importance for nitrate leaching are determined.

We especially need knowledge about how the hydraulic parameters are affected by the farming system, and if there are aspects of organic farming systems that generally result in an increased leaching of dissolved organic carbon (DOC) from the plough layer, which can promote a DOC-driven denitrification in the subsoil of leached nitrate. We have identified four management tools that we think would be of particular importance to investigate. These are: (1) the level of application of farmyard manure, (2) the effect of crop rotation and catch crops on the hydraulic properties and denitrification, (3) the effect of N-fixing plants on denitrification, and the effect of tillage systems such as on-land ploughing (4) on hydraulic properties.

On the basis of these investigations we will be able to recommend systems of organic farming that are better able to reduce nitrate leaching and which will be tested in model scenarios to calculate the leaching from the vadose zone. Further, some of the scenarios will be modelled for a catchment area to see whether the effects will persist in ground water at the regional level.

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

WP No	WP title	Partici-pants*	Budget (in kkr)	Start	End	Deliver-able, No
1	Project co-ordination	<u>OHJ</u>	135	2002/04	2005/07	D1(1-4)
2	Identification of relevant organic farm systems	<u>JEO</u> All	60	2002/04	2005/07	D2.(1-2)
3	Effect of organic farm systems on soil structure and hydraulic parameters	<u>PS</u> OHJ	698	2002/09	2004/12	D3.(1-5)
4	Effect of organic farming systems on DOC mobilisation and DOC-assisted denitrification	<u>FPV</u> HCBH, PS, HHJ	1255	2002/04	2004/12	D4.1-4 13 i alt
5	Root and vadose zone modelling	<u>SH</u> LSJ	612	2002/06	2005/07	D5.1-2 3 i alt
6	Regional modelling of nitrate to ground water	<u>MS</u> MH	240	2004/01	2005/07	D6.1
<b>Total</b>			3000			

\* Responsible participants are underlined

## B. Objectives and expected achievements

to determine the effect of different organic farming systems on ground water by model calculations and from this to recommend some organic farming systems that are optimal in relation to the amount of good quality ground water.

to create the model input and adjustment with regard to the effect of different organic farming systems on the soil hydraulic properties and leaching of soluble organic matter and its role for supporting denitrification.

## C. Midterm results and progress

### C.1 Description (summary) of main results and conclusions

WP 3: All samplings have followed the plan mentioned in the 2002 Status Report. At each location, cores in undisturbed condition were sampled at the depths 0-20, 20-40 and 40-60 cm. We used two core sizes: 100 cm<sup>3</sup> and ~6000 cm<sup>3</sup>. The small cores are intended for water retention and air permeability measurements in order to describe the pore system. The large cores are intended for determination of hydraulic parameters.

“The long-term fertilisation trial” (LTF) at Askov: All samplings took place in November 2002.

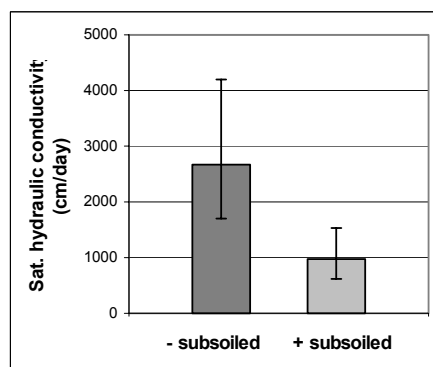
“The Crop Rotation Experiment” (CRE) at Foulum: Half the plots were sampled in November 2002 and half the plots will be sampled in October 2003 (we followed the crop rotation and sampled two replicates each of the two years).

“The tillage trials at Rugballegaard” (ITR): All samplings took place in November 2002.

“The Grass/clover Experiment” (GCE) at Foulum: Samplings will take place in October 2003.

At present all 100 cm<sup>3</sup> cores sampled have been analysed according to the plan. Due to a break down of the drip infiltrometer, only the large cores from the TTR have yet been analysed for the hydraulic properties.

In Fig. 3.1 is some results from the TTR trial at Rugballegaard. Due to very large variation it was difficult to see any effects of the treatments. However, we measured the soil texture of the different samples in order to statistically remove the effects of differences in soil type. We did only find statistically significant effects for saturated hydraulic conductivity (Fig. 3.1), which surprisingly were lower for the subsoiled plots. But this is actually in accordance with the results obtained in the DACROF project ROMAPAC where root growth seems to be restricted in the subsoiled plot because there are less continuous larger pores.



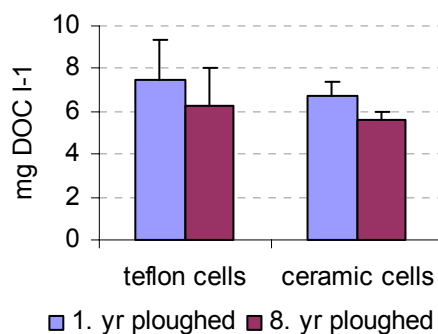
**Fig. 3.1.** Saturated hydraulic conductivity in +/- subsoiled plots in the tillage trials at Rugballegaard. Statistically test on log transformed values. Effects of soil variability are removed.

#### WP 4.1 Quantification of amount and export of DOM from different soil layers

In order to evaluate the contribution from grassland to DOM export, DOM has during the past winter been quantified in the Grass-Clover Experiment (GCE) with the focus on determining the effects of ploughing under grass-clover. In this experiment, existing ceramic suction cups installed in 100 cm depth were compared with Teflon cups in 90 cm. Additional Teflon suction cups were installed 30 and 60 cm in 1<sup>st</sup> and 8<sup>th</sup> year ploughed grass-clover and an existing 9<sup>th</sup> year grass-clover (Fig. 4.1.1). The data are not yet fully analysed, and the results should be considered as preliminary.



**Fig. 4.1.1.** Installation of Teflon suction cups in the grass-clover field.

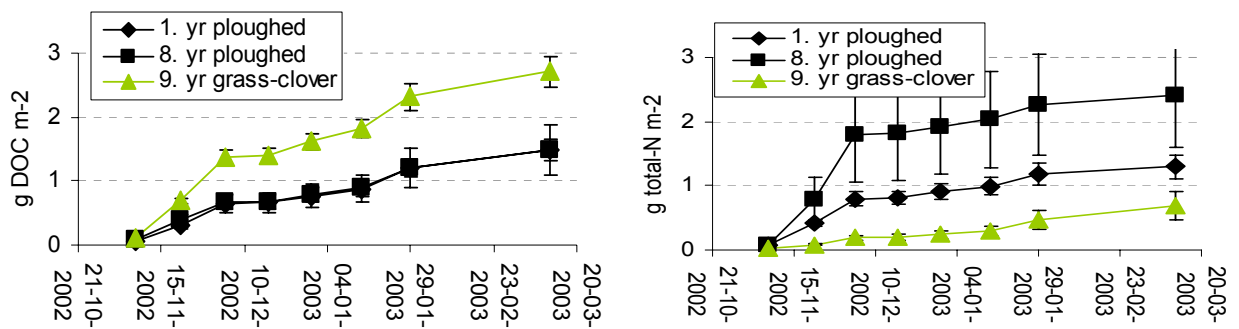


**Fig. 4.1.2.** Concentration of DOC in 1 m. sampled with teflon and ceramic suction cells under a 1<sup>st</sup> and 8<sup>th</sup> year ploughed grass-clover.

Comparison of DOC concentration between Teflon and ceramic suction cells showed no significant difference (Fig. 4.1.2).

Leaching of DOC comprised about  $1.5 \text{ g m}^{-2}$  in the 1<sup>st</sup> and 8<sup>th</sup> year ploughed grass-clover and  $2.8 \text{ g m}^{-2}$  in the 9<sup>th</sup> year grass-clover (Fig. 4.1.3). Leaching of total N was opposite with the highest amounts in the ploughed treatments (Fig. 4.1.3). Total N,  $\text{NO}_3\text{-N}$  and  $\text{NH}_4\text{-N}$  were measured in the leachate, which made it possible to calculate the amount of dissolved organic nitrogen (DON). These results indicated that org. N comprised 22, 18 and 47% of the total N in the 1<sup>st</sup> and 8<sup>th</sup> year ploughed and 9<sup>th</sup> year grass-clover, respectively. In other words, measurements of  $\text{NO}_3\text{-N}$  only expressed from 50 to 80% of the total N leaching.

It should however be mentioned that these results are obtained from one soil type and from a grass-clover system, where the proportion of organic N probably is higher than in other cropping systems. Therefore, more measurements are needed in other systems and other soil types before more general statements can be achieved.



**Fig. 4.1.3.** Leaching of dissolved organic carbon (DOC) and total N ( $\text{NO}_3\text{-N} + \text{NH}_4\text{-N} + \text{org. N}$ ) in a 1<sup>st</sup> and 8<sup>th</sup> year ploughed grass-clover and a 9<sup>th</sup> year grass-clover.

The data presented here is only a summary of measurements in 90 cm depth, which together with measurements in 30 and 60 cm will be used for calibrations of the transport module of Daisy (WP 5).

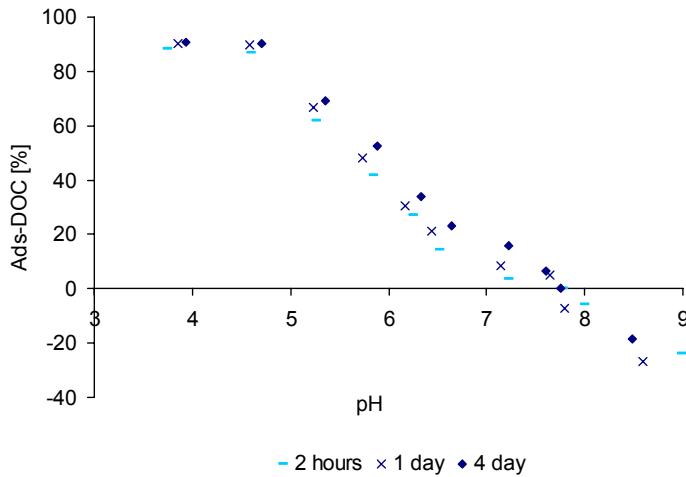
#### WP 4.3 Sorption of DOM from different sources

WP4.3: Dissolved organic matter (DOM) has been extracted from the Burkhøj (Foulum) Ap horizon using Na-saturated Chelex 100 resins. 10 g of soil was extracted with 50 g of Chelex resin in the presence of 200 ml of water. The bottles were gently turned upside down manually twice per day. The low shaking intensity was necessary in order to avoid release of carbon from the resin. Extraction continued up to 140 hours. When no pH adjustment was applied pH increased to about 10; DOC concentrations in the supernatant were 70 mmol C/l at day 140 h corresponding to about 50 % of all carbon in the soil. At lower pH (5 or 7) only about 30 - 40 % of this amount of carbon was extracted. The extracted DOM was stored at 5 °C for further use in sorption experiments. Part of the DOM was freeze dried for later chemical and spectroscopic analysis.

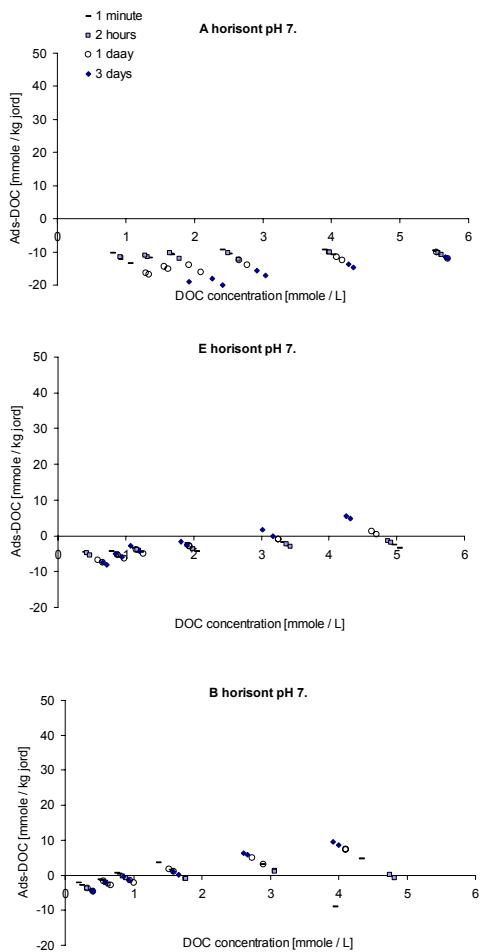
Sorption experiments were carried out with A, E, and B horizons from the Burkhøj soil. 20 g of soil was preequilibrated at pH 5 or 7 and DOM solutions added to achieve initial DOC concentrations in the range 0 - 5 mM. The soil:solution ratio was 10, the electrolyte concentration approximately 10 mM NaCl and the temperature about 20 °C. After shaking for different periods of time (1 min, 2 h, 1 d, 3 d) the soil suspension was sampled and filtered (0.45  $\mu\text{m}$ ), and the fil-

trate analysed for total concentration of dissolved carbon (TOC), nitrogen (TDON), phosphorus (TDOP) and orthophosphate (DIP). In a separate experiment the sorption of DOM versus pH (4 - 9) was tested at a fixed initial concentration of DOM.

Examples of DOM sorption are shown below. Sorption is very sensitive to pH as seen from Fig. 4.3.1. This is also seen in sorption isotherms where sorption is much less at pH 5 than at pH 7 (Fig. 4.3.2).



**Fig. 4.3.1** Relative sorption of DOM to Burkhøj E horizon versus pH in equilibrating solution



**Fig. 4.3.2.** Sorption isotherms for bonding of DOM to Burkhøj A, E and B horizon soil materials at pH 5 and 7 determined at different times of reaction between DOM and soil material.

It is seen, that:

- sorption strongly increases with time in particular at pH 5 and at higher DOM concentrations.
- the affinity for sorption of DOM is 3 - 5 times higher for the E and B horizons than the A horizon at pH 5.
- no sorption maximum is observed within the tested DOC concentrations
- DOM is released from the soil at low added DOM concentrations; this is most pronounced for the A-horizon
- sorption is much lower at higher pH than at lower pH. The A-horizon does not sorb DOM at pH 7, but rather desorbs DOM. Also the E and B horizons desorb DOM at pH 7 up to solution DOC concentrations of 1 - 2 mM.

Additional experiments have shown, that the sorption of DOM is rather sensitive to the concentration of  $\text{Ca}^{2+}$ ; e.g. in presence of 0.01 M  $\text{CaCl}_2$  electrolyte the sorption (precipitation?) of DOM is strongly increased. However, the solution concentrations of  $\text{Ca}^{2+}$  in the sorption experiments with NaCl electrolyte were not significantly different from the  $\text{Ca}^{2+}$  concentrations measured in the soil solution sampled with suction cells at the Burkhøj field (A horizons). Hence, as the  $\text{Ca}^{2+}$  concentrations are at the same level the low sorption of DOM observed at pH 7 seems not to be an artefact due to the experimental conditions.

The data for TDOP and TDON is currently being analysed. The working hypothesis is that the N and P in DOM is sorbed proportionally to the sorption of DOC according to the C:N:P ratio in the DOM added. Deviations from this behaviour will demonstrate to which extent fractionation is taking place during sorption.

The results indicate that DOM can be mobilised from A horizons and that the soil pH exerts a strong control on the mobility of the DOM. Furthermore, the observation that about 50 % of the total soil content of C can be extracted by use of Chelex resins is quite unexpected. This indicates that a large fraction of the soil humic substances in this particular soil can be mobilised and is more bioavailable than previously thought.

#### **WP 4.4 Effects of DOC on denitrification**

In the natural environment all factors, such as pore size and distribution, oxygen status and water potential, act simultaneously, and to estimate denitrification under 'real life' conditions it is therefore important to measure on intact soil samples, where also a number of soil physical characters will be measured (WP 3). The results of these measurements from the long-term fertiliser experiment (LTF) are summarised in Fig. 4.4.1 and the crop rotation experiment (CRE) in Fig. 4.4.2. Results from the grass-clover experiment (GCE) are still not available.

Although not yet statistically treated, the preliminary data in Fig. 4.4.1 indicate a significant effect of carbon addition, water potential as well as soil depth on the denitrification activity. Further, the different scales on the y-axis indicate a considerable higher denitrification in the long-term fertiliser experiment located on a sandy loam soil at Askov than in the crop rotation experiment located on loamy sand in Foulum. The data have not yet been analysed for possible effects of the field treatments, i.e. fertiliser additions or crop rotations, nor been related to the soil physical parameters measured in WP 3.

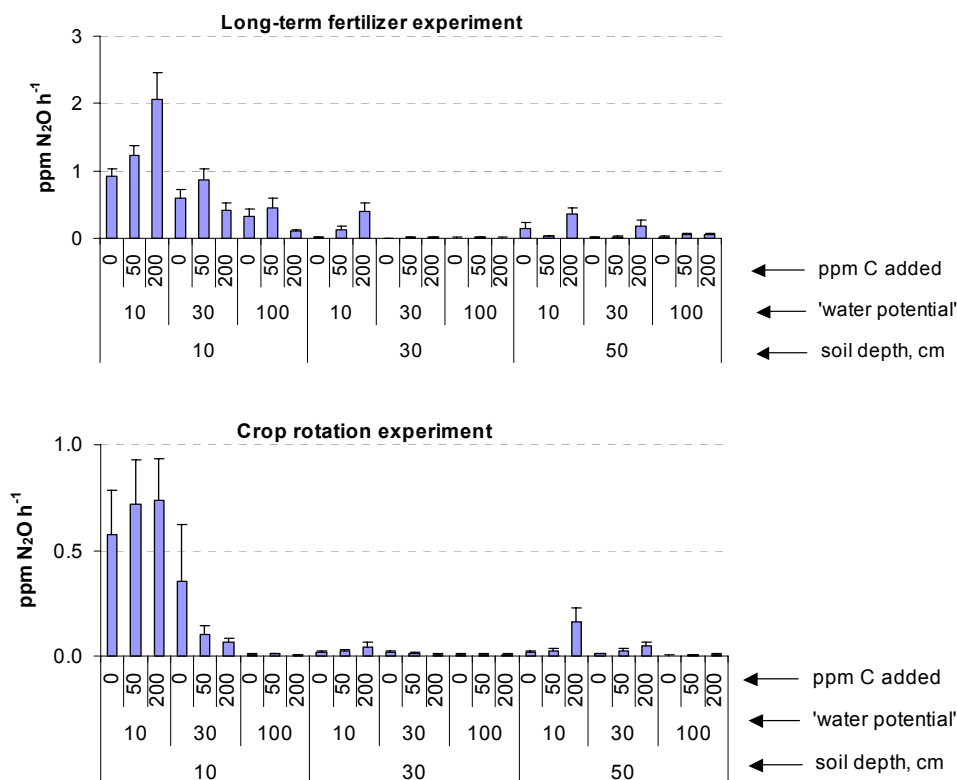


Fig. 4.4.1. Denitrification activity in intact soil samples with different amounts of added carbon, soil water potential (cm hanging H<sub>2</sub>O-column) and soil depth.

WP5: The new developed DOM module has been tested with the sparse numbers available from literature, and the dynamics seemed plausible. We thus believe the structure of the DOM module is ready to be parameterised when reliable data from WP4 become available later this autumn. The denitrification module has been recalibrated to be in line with observations made by Finn P. Vinter. The organic matter turnover module have been recalibrated as part a Daisy Standardisation project, financed by Danish Environmental Protection Agency, the counties (amterne), and the Danish Agricultural Advisory Service. Further calibration and some structural changes to that module are being made as part of the BIOMOD project.

## C.2 Fulfilment of deliverables and milestones

(To be completed for each work package)

WP1: Project co-ordination	Time schedule according to application	Deviations, if any*
<b>Deliverables</b>		
D 1.1 First annual report 2002	2002/10	OK
D1.2. Second annual report 2003	2003/10	OK
D1.3. Third annual report 2004	2004/10	
D1.4. Report with optimal organic farming systems (See M2.3 and 5.5)	2005/07	
D1.5. Final report 2005	2005/07	
<b>Milestones</b>		
M1.1 First annual report completed	2002/10	OK
M1.2 Second annual report completed	2003/10	OK
M1.3 Third annual report completed	2004/10	
M1.4 Final report completed	2005/07	

<b>WP2: Identification of relevant organic farm systems</b>	Time schedule according to application	Deviations, if any*
<b>Deliverables</b>		
D2.1 Suggestions of organic farming systems and crop rotation to test in the project	2002/06	OK
D2.2 Description of agricultural practices in the farming systems for use in simulations	2003/12	
D2.3 List with optimal organic farming systems	2005/07	
<b>Milestones</b>		
M2.1 Agreement on farming systems to test	2002/06	OK
M2.2 Agreement on agricultural description for model simulations	2003/12	
M2.3 Report with optimal organic farming systems (See M1.4 and M5.5)	2005/07	

<b>WP3: Effect of organic farm systems on soil structure and hydraulic parameters</b>	Time schedule according to application	Deviations, if any*
<b>Deliverables</b>		
D3.1 Effect of management tools on porosity, retention curves, saturated and unsaturated hydraulic conductivities	2003/12	
D3.2 Effect of management tools on tortuosity and pore connectivity	2003/12	
D3.3 Semi-quantitative description of depth and distribution of roots and macropores in the field trials	2003/05	Partly
D3.4 Soil physical characterised soil samples for the denitrification incubation experiments	2003/08	OK
D3.5 Suggestions on how to extrapolate parameter effects to other soil types	2004/04	
<b>Milestones</b>		
M3.1 Sampling in the field trials finished	2003/10	Nearly finished. Last sampling planned
M3.2 Data of hydraulic properties and pore characterisation parameters delivered to modellers	2003/12	
M3.3 Soil samples for the denitrification incubation delivered	2003/08	OK
M3.4 Agreement on how to extrapolate parameter effects to other soil types	2004/03	

<b>WP4: Effect of organic farming systems on DOC mobilisation and DOC-assisted denitrification</b>	Time schedule according to application	Deviations, if any*
<b>Deliverables</b>		
D4.1-1 Field record of the time dependent profile DOC (including DON) concentrations under conditions of high carbon and nitrogen turnover	2003/12	OK
D4.1-2 DOM isolates for further characterisation in WP 4.2 and for use in sorption work in WP 4.3	2003/05	OK
D4.1-3 Dataset for calibration of DOC modelling by DAISY	2003/12	
D4.2-1 Determination of origin of DOM in grass-clover mixtures	2003/07	see below
D4.2-2 Determination of the composition of DOM originating from specific species	2003/12	see below
D4.2-3 Determination of the contribution of single species to the mobile part of the DOM	2003/07	see below
D4.2-4 DOM pulse as related to precipitation intensity	2003/07	see below
D4.3-1 Quantitative measures of DOC bonding according to soil composition, DOC composition and DOC concentration	2003/12	Almost done
D4.3-2 Selective sorption of specific DOC fractions during sorption	2003/07	2003/11
D4.3-3 Input parameters to DAISY modelling of DOC dynamics	2003/12	

D4.4-1 Determination of soil physical characteristics on intact soil cores for denitrification measurements	2003/06	2003/11
D4.4-2 Dataset from measurements on intact soil cores for calibration of Daisy denitrification sub-module	2003/12	OK
D4.4-3 Influence of DOC on potential denitrification as a function of crop type, organic fertiliser input	2003/12	OK
<b>Milestones</b>		
M4.1-1 Teflon suction cups installed	2002/09	OK
M4.1-2 Sampling from suction cups and analysis of DOC finalised	2004/04	OK
M4.2-1 Soil column studies about origin of DOM in grass-clover mixtures completed	2003/05	see below
M4.2-2 Dataset for calibration of DOC modelling by DAISY delivered	2003/09	see below
M4.3-1 Studies on DOM sorption and composition completed	2003/08	Almost finished
M4.3-2 Sorption parameters for calibration of DOC modelling by DAISY delivered	2003/09	2003/12
M4.4-1 Studies on relationships between DOC, soil physical characters and denitrification completed	2004/03	
M4.4-2 Dataset for calibration of denitrification sub-module in DAISY delivered	2004/03	
M4.4-3 Studies on the influence of DOC on potential denitrification as a function of crop type, organic fertiliser input and soil depth completed	2004/03	

<b>WP5: Root and vadose zone modelling</b>	Time schedule according to application	Deviations, if any*
<b>Deliverables</b>		
D5.1-1 Operational DOC module in DAISY	2004/01	
D5.2-1 Scenario simulations of the suggested organic farming systems and standard conventional systems	2004/09	
D5.2-2. Input data for regional groundwater simulations	2004/09	
<b>Milestones</b>		
M5.1-1 DOC module ready	2003/12	Almost ready
M5.2-1 Agreement on agricultural description	2003/12	
M5.2-2 Scenario simulation finished	2004/10	
M5.2-3 Input data delivered to WP6	2004/10	
M5.2-4 Report with optimal organic farming systems (See M1.3 and M2.3)	2005/07	

<b>WP6: Regional modelling of nitrate to ground water</b>	Time schedule according to application	Deviations, if any*
<b>Deliverables</b>		
D6.1. Report describing the results of the upscaling exercise	2005/07	
<b>Milestones</b>		
M6.1. Agreement on choice of groundwater model (2002/10)	2002/10	
M6.2. Agreement on agricultural description	2003/12	
M6.3. Report describing the results of the upscaling exercise	2005/07	

\* *Deviations are to be further discussed in D*

## D. Description of deviations and subsequent adjustments of plans

### WP3

We had a breakdown of our automatic drip infiltrometer. After large efforts at our workshop to repair it we are at the moment trying to get it repaired in Holland and our best guess is that we still will have the measurement finish by this year.

We decided not to do the semi-quantitative description of depth and distribution of roots because of the knowledge we already have and because the information not could be used direct in the modelling. The macropore description still can be elucidated from the water and air transport measurements.

#### **WP4**

##### **WP4.2**

There has been a change in plans so that the work in this workpackage became included in Ph.D. study in SOA. This has delayed the work. Further the Ph.D. student resigned and a new call for applicants is send out. This will further delay this workpackage. This is not optimal, as the modelers are dependent on these data. The modellers in WP 5 therefore have to make use of the data from the other workpackages first.

WP4.3. It was originally planned to isolate DOM from soil water from suction cells. However, due to the rather low volumes of soil water gained from the suction cells and the low DOC concentrations in the soil water, it was decided to isolate DOM in a different way. We have used the Chelex resin method for isolation of DOM as this method does not imply the use of strong acids or bases, and because the use of this method is well documented. The Chelex resins extract metal cations like  $\text{Ca}^{2+}$ ,  $\text{Fe}^{3+}$  and  $\text{Al}^{3+}$  from the soil thus causing liberation of DOM to the solution. Thus the method is a rather gentle method only causing a minimum of disturbance of the soil.

## **E. Project publications and other products**

Papers and reports labelled with one and two asterisks (\* / \*\*) have been produced with 25-75% and 5-25%, respectively, of the costs paid by the ROMAPAC project. Non-labelled papers have been fully paid by the project.

### 1. Articles in international, scientific journals with review procedures

\*\*Munkholm, L.J., Schjønning, P. & Rüegg, K. Mitigation of subsoil recompaction by light traffic and on-land ploughing: I. Soil response. *Soil & Tillage Research* (submitted).

\*\*Munkholm, L.J, Schjønning, P., Jørgensen, M.H. and Thorup-Kristensen, K. Mitigation of subsoil recompaction by light traffic and on-land ploughing:II. Root and yield response. *Soil & Tillage Research* (submitted).

### 2. Papers presented at congresses, symposiums, etc.

\*\*Munkholm, L.J. & Schjønning, P. 2003. Mechanical subsoiling: Mitigation of recompaction by light traffic and on-land ploughing. *Proceedings, 16<sup>th</sup> Int. Conference of the International Soil Tillage Research Organization, Brisbane, Australia, July 2003, pp. 813-819.*

### 3. Reports, articles in agricultural journals, etc.

Vinther, F. P. (2002) Hvor bliver kvælstoffet af? Klumme til *Økologisk Jordbrug*, okt. 2003

\*\*Munkholm, L.J. & Schjønning, P. 2003. Compacted subsoils in organic farming: Mechanical loosening and the risk of recompaction. *DARCOF Enews*, No. 3, Oct. 2003.

\*\*Schjønning, P., Munkholm, L.J. & Elmholt, S. 2003. Jordkvalitet og dyrkningsmetoder. I: Holmstrup, M. (red.) Økologisk landbrug og naturen - gør økologisk landbrug en forskel for natur og miljø? Danmarks Miljøundersøgelser. Gads Forlag, København, pp. 9-19.

## **F. Scientific education**

WP3 RVAU student Lene Mathiasen is writing her masters thesis at Foulum in connection with the work on WP3 concentrating on the tillage trials at Rugballegaard.

WP4.2. This project is now part of a Ph.D. project within SOA

WP4.3 and 5. This project is part of a current Ph.D. project for Birgitte Gjetterman on dissolved organic matter mobilisation and transport.

## **G. National and international co-operation**

We are using the experimental area described in DARCOF project VII.11. The two projects work in close collaboration experimentally and in the interpretation of data. The experiment is labelled the "Grass-clover experiment" (GCE). (Contact: Jørgen Eriksen, DIAS)

In November 2002 we will sample in the long-term crop rotation experiment that is financed by DARCOF project II-23 "Experimental units for research in organic farming systems" (EXUNIT) (Contact: Jørgen E. Olesen, DIAS), in long-term fertiliser experiments in Askov (Contact: Bent T. Christensen, DIAS) and in "The Row Cropping Experiment" in Bygholm (Contact: Per Schjønning, DIAS)

Several of the participants in this project are involved the DARCOF project "Interaction between nitrogen dynamics, crop production and biodiversity in organic rotations analysed by dynamic simulation models" - BIOMOD (LSJ, SH, JEO, FPV) and we make use of the improvements of Daisy and data input to simulate organic farming systems.

We applied for a Marie Curie postdoc grant (EU) to Mathieu Lamandé at INRA, Rennes, France for a to year project (Impact of cropping systems on soil structure and physical properties - consequences on water and solute transport) which would have been closely connected to the ØKOVAND project. Unfortunately it was not granted, but we are at the moment searching for other possibilities to continue the co-operation.

Further international co-operation is planned according to the proposal

## **H. Critical reflection on the project**

The project is still in its data collecting phase and this makes it difficult really to reflect on if the scientific approach has proven to be the right one. But nothing has convinced us that it is not. The idea to use models to integrate the different effects of organic farming on nitrate leaching and therefore concentrate on measuring the effects on the model parameters is the only way we can integrate the interaction between farming system, climate and soil types for a reasonable economic frame.

During the data collecting phase we have discovered a few more specific things that gives us rea-

son to expand investigations or have methodological changes.

Measurements of total N in leachate (WP 4.1) from grass-clover cropping systems on loamy sand have indicated that organic N may contribute significantly to the total N-leaching. However, before a general conclusion concerning recommendations of routine measurements of total N can be drawn, the contribution from organic N needs to be investigated in other cropping systems and on other soil types.

In WP4.3 we have found that a comparison of DOM extracted with the resin method and DOM in the soil water from the suction cells is important because the use of DOM isolated by means of Chelex resin is of great use in microbial investigations of denitrification potential.

## 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:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	5	17	8	5.5		
Technical personnel	3.2	15.2	5.2	0.3		

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	211	674	361	276		
Technical personnel	78	384	134	7		
Other operational costs	71	175	93	36		
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	72	247	117	64		
Total	432	1480	705	383		3000

**Comments:**

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## 9. Signatures and stamps

Name	Institute	Date	Signature
Head of project			
Ole Hørbye Jacobsen	DIAS	Sep. 31 2003	

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## Appendix I. Detailed budget

### A. Budget for each participating institute (1.000 DKr)

Name of Institute: Danish Institute of Agricultural Sciences, Department of Crop Physiology and Soil Science

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	3	12	2.5	3		
Technical personnel	1.3	11.7	3.2	0.3		

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	131	474	121	156		
Technical personnel	30	300	86	7		
Other operational costs	39	81	24	9		
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	40	171	46	35		
Total	240	1026	277	207		1750

**Comments:**

Name of Institute and department: The Royal Veterinary and Agricultural University,  
Department of Agricultural Sciences

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	2	5	4	1		10
Technical personnel		1.5	1			2.5

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	80	200	160	40		480
Technical personnel		36	24			60
Other operational costs	3	51	32	7		93
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	17	58	43	9		
Total	100	345	259	56		760

**Comments:**

Name of Institute and department: The Royal Veterinary and Agricultural University,  
Chemistry Department

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel						
Technical personnel	2	2	1			

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel						
Technical personnel	48	72				
Other operational costs	29	49	11			
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	15	24	2			
Total	92	145	13			250

**Comments: They want to finish the data collecting this year and therefore to use man month in the budget next year already within this year.**

Name of Institute: DHI Water &amp; Environment

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel			1.5	1.5		
Technical personnel						

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel			80	80		
Technical personnel						
Other operational costs			20	20		
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)			20	20		
Total			120	120		240

**Comments:**

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

Name of Institute: The Royal Veterinary and Agricultural University

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	3.5	3.5	2.5	1.5		
Technical personnel	2	6	2			

**Comments:**