**Danish Research Centre for Organic Farming**

# Midterm Status Report 2002 and Application for Continuation in 2003

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

## 1. Research program

Research in organic farming 2000-2005 (DARCOF II)

## 2. Project title and number

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

## 3. Head of project

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## 6. Project period (month, year)

Start of project: April 2002

End of project: July 2005

# 7. Midterm description of the project, its results and progress, and application for continuation in 2003

## 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 | OHJ | 135 | 2002/04 | 2005/07 | D1(1-4) |
| 2 | Identification of relevant organic farm systems | JEO All | 60 | 2002/04 | 2005/07 | D2.(1-2) |
| 3 | Effect of organic farm systems on soil structure and hydraulic parameters | PS OHJ | 698 | 2002/09 | 2004/12 | D3.(1-5) |
| 4 | Effect of organic farming systems on DOC mobilisation and DOC-assisted denitrification | FPV HCBH, PS, HHJ | 1255 | 2002/04 | 2004/12 | D4.1-4 13 i alt |
| 5 | Root and vadose zone modelling | SH LSJ | 612 | 2002/06 | 2005/07 | D5.1-2 3 i alt |
| 6 | Regional modelling of nitrate to ground water | MS MH | 240 | 2004/01 | 2005/07 | D6.1 |
| **Total** | | | 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 1: P*roject group meeting was held in March.

*WP2 and 3:* Based on the conclusion from the project meeting we have decided upon which management effects we think is most important to concentrate on. We will measure the hydraulic properties in "The Grass/clover Experiment" (GCE) in Foulum, "The long-term fertilisation trial" (LTF) at Askov (one having received plant nutrients only as farm yard manure (slurry) and the other only as commercial NPK dressings), "The Crop Rotation Experiment" (CRE) in Foulum (on is the 'poor' rotation with spring barley, spring oats, spring wheat and lupine with no catch crops and no animal manure applications and the other the versatile rotation with spring barley undersown with a grass/clover mixture, grass/clover mixture for green manure, winter wheat with undersown catch crop of ryegrass, lupine with undersown catch crop of ryegrass) and

finally "The tillage trials at Rugballegaard" (TTR) (one being subsoiled and afterwards treated with on-land ploughing and one traditionally ploughed). Sampling vil be performed in November 20002 for CRE, TTR and LTF.

*WP 4:* Before the project was officially started, and two weeks before the grass-clover pastures of different age and usage were ploughed under (primo April), measurements of dissolved organic carbon (DOC) were carried out. Soil water was collected from existing ceramic suction cups placed in 1 m depth (installed in 1996). The measurements were carried out to obtain preliminary levels of DOC in the soil water before installation of suction cup in different depths in order to study the dynamics and quality of DOC after ploughing under pastures of different age.

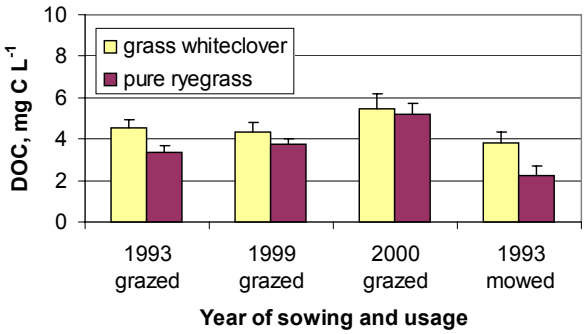


*Fig 1. Content of dissolved organic carbon (DOC) in leachate from suction cups installed at 1 m depth under pastures of different age and usage (mean ± S.E., n = 25 (grazed) & 8 (mowed)).*

The results (Fig. 1) indicate that the content of DOC was higher under grazed pastures than under mowed pastures, that DOC was higher under grass-white clover pastures than under pure ryegrass pastures, and that DOC in 1 m depth decreased with increasing pasture age.

*WP 5*: WP 5 has instantiated cooperation with a PhD project dealing with phosphorus dynamics in agricultural soil. Common interest the modeling of mobilization of DOM (dissolved organic matter, including DOC and DOP (dissolved organic phosphorus)). The present state of the modeling work within WP 5 is that the organic matter turnover module of Daisy has been further developed and implemented in order to simulate mobilization of DOC. Within the framework of the PhD project a standalone version of this module has been used to obtain a preliminary parameterization of the model. This parameterization is based on literature data. Also within the PhD study a literature review on DOM (DOC, DON and DOP) is ongoing. The final decision on the structure of DOM mobilization model and the corresponding sorption and transport models awaits the finalization of this review.

## 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* |
|---|---|---|
| Deliverables | | |
| 1 First annual report 2002 | 2002/10 | |
| | | |
| Milestones | | |
| 1 First annual report completed | 2002/10 | |
| | | |

| WP2: **Identification of relevant organic farm systems** | Time schedule according to application | Deviations, if any* |
|---|---|---|
| Deliverables | | |
| 1 Suggestions of organic farming systems and crop rotation to test in the project | 2002/06 | |
| | | |
| Milestones | | |
| 1 Agreement on farming systems to test | 2002/06 | |
| | | |

| WP3: **Effect of organic farm systems on soil structure and hydraulic parameters** | Time schedule according to application | Deviations, if any* |
|---|---|---|
| Deliverables | | |
| 1 First annual report 2002 | 2002/10 | |
| | | |
| Milestones | | |
| 1 First annual report completed | 2002/10 | |
| | | |

| WP4: **Effect of organic farming systems on DOC mobilisation and DOC-assisted denitrification** | Time schedule according to application | Deviations, if any* |
|---|---|---|
| Deliverables | | |
| 1 First annual report 2002 | 2002/10 | |
| | | |
| Milestones | | |
| 1 Teflon suction cups installed | 2002/09 | |
| | | |

| WP5: **Root and vadose zone modelling** | Time schedule according to application | Deviations, if any* |
|---|---|---|
| Deliverables | | |
| 1 First annual report 2002 | 2002/10 | See D |
| | | |
| Milestones | | |
| | | |
| | | |

| WP6: **Regional modelling of nitrate to ground water** | Time schedule according to application | Deviations, if any* |
|---|---|---|
| Deliverables | | |
| | | |
| | | |
| Milestones | | |
| 1.Agreement on choice of groundwater model | 2002/10 | |
| | | |

** Deviations are to be further discussed in D*

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

**WP4**

The main aim in WP4.2 is to determine the origin and composition of DOM in grass-clover mixtures. Following discussions with colleagues that have experience with working with whole columns of soils under controlled conditions, it has been decided to change the methodological approach due to too many problems associated with managing the columns.

Thus, it has been decided that in addition to the work with columns under controlled conditions, mezotrons will be inserted under field conditions on a suitable location at Højbakkegaard.

Due to the unusual dry conditions this autumn it has not been possible neither i) to take out intact soil columns and transfer to the lab nor ii) to insert mezotrons into existing grassland and thus start labelling the plants while still in the growing season.

Consequently, mezotrons will be inserted into existing 2-years old grass-clover at Højbakkegaard during the coming winter. This has to take place at a time when the soil is completely water-saturated. Labelling of individual plants in the mezotrons will start summer 2003 and the leachates will be collected from November and forward. A non-reactive tracer – possible Boron – may be employed to control that there will be no difference in the leaching characteristic of each column through the establishment of break-through curves following placement of the boron salt on the soil surface.

Intact soil columns will be taken from the same area during the coming winter and transported to the lab for further experiments. The aim is that this study should be part of an international collaboration with a visiting researcher from Shanghai.

Thus, we request that the budgeted funding for 2002 is transferred to 2003. This delay will not influence other WPs.

**WP5**
Work Package 5 has postponed the modelling work 4 months in order to make full use of the cooperation with a PhD study. This requires transfer of funding from 2002 to 2003, however it does not influence the timing of the first milestone of the Work Package, and do not influence the other work packages.

## E. Project publications and other products

No publications yet

## F. Scientific education

No scientific education yet

## G. National and international cooperation

## H. Critical reflection on the project

# 8. Budget

## A. Account for any change in budgets

Due to the late start, capacity problems, dry soil and the late start of a Ph.D study we want to move 452 kkr. of the budget from this year to next year. This will not have any consequences for the overall plan of the project

## B. Budget for the whole project (1.000 DKK)

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

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Man-months | | | | | | |
| Scientific personnel | | 5 | 17 | 8 | 5.5 | |
| Technical personnel | | 3.2 | 15.2 | 5.2 | 0.3 | |

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | 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 | |

**Comments:**

# 9. Signatures and stamps

| Name | Institute | Date | Signature |
|---|---|---|---|
| Head of project<br><br>Ole Hørbye Jacobsen | DIAS | Sep. 31 2002 | |

# 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: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Man-months | | 3 | 12 | 2.5 | 3 | |
| Scientific personnel | | 1.3 | 11.7 | 3.2 | 0.3 | |
| Technical personnel | | | | | | |

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | 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:**
Due to capacity problems in our laboratory soil sample measurements will be moved from the end of this year to the start of next year. This will not influence milestones or deliverables.

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

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Man-months | | | | | | |
| Scientific personnel | | 2 | 5 | 4 | 1 | 10 |
| Technical personnel | | | 1.5 | 1 | | 2.5 |

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | 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: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Man-months<br><br>Scientific personnel<br><br>Technical personnel | | 2 | 2 | 1 | | |

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Salaries<br><br>Scientific personnel<br><br>Technical personnel | | 48 | 48 | 24 | | |
| Other operational costs | | 29 | 43 | 17 | | |
| Equipment | | | | | | |
| Others (please specify) | | | | | | |
| Direct costs | | | | | | |
| Indirect costs<br>(20% of direct costs) | | 15 | 18 | 8 | | |
| Total | | 92 | 109 | 49 | | |

**Comments:**

Name of Institute: DHI Water & Environment

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Man-months<br>Scientific personnel<br>Technical personnel | | | | 1.5 | 1.5 | |

| Year: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Salaries<br>Scientific personnel<br>Technical personnel | | | | 80 | 80 | |
| Other operational costs | | | | 20 | 20 | |
| Equipment | | | | | | |
| Others (please specify) | | | | | | |
| Direct costs | | | | | | |
| Indirect costs<br>(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: | Consump-tion before 2002 | Expected consumption 2002 | 2003 | 2004 | 2005 | Total |
|---|---|---|---|---|---|---|
| Man-months | | | | | | |
| Scientific personnel | | 3.5 | 3.5 | 2.5 | 1.5 | |
| Technical personnel | | 2 | 2 | 2 | | |

**Comments:**