



Midterm Status Report 2003 and Application for Continuation in 2004

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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

Interactions between nitrogen dynamics, crop production and biodiversity in organic crop rotations analysed by dynamic simulation models – Project Number I,3.
Acronym: BIOMOD

3. Head of project

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6. Project period (month, year)

Start of project: August 2000

End of project: December 2003 (Extended to 2004)

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

A. Project summary

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

| Work-package No. | Work package title | Responsible participant | Budget | Start | End | Deliverable No |
|------------------|---|-------------------------|-----------|---------|---------|----------------|
| 1 | Adaptation of a model for competition between undersown crops and main crops | JB | 940,256 | 2000/04 | 2003/06 | D1-D4 |
| 2 | Improvement of root growth model | KTK | 898,182 | 2000/10 | 2003/06 | D5-D7 |
| 3 | Parameterisation of the soil organic matter turnover sub-modules of DAISY and FASSET | BMP | 677,320 | 2000/10 | 2002/12 | D8-D11 |
| 4 | Crop production, nitrogen balance, nitrate leaching and biodiversity in crop rotations on private farms | JEO | 2,372,420 | 2000/04 | 2003/10 | D12-D13 |
| 5 | Whole model calibration, validation inter-comparison and scenario analyses | JAA | 3,019,830 | 2000/10 | 2003/12 | D14-D17 |
| 6 | Parameterisation of the release from the roots | JB | 220,951 | 2001/03 | 2002/06 | D18-19 |
| 7 | Validation and further development of a solute transport model | JB | 227,361 | 2001/06 | 2002/12 | D20-22 |
| 8 | Measurements in field experiments | JEO | 357,660 | 2001/03 | 2002/03 | D23-24 |

* Responsible participants are underlined

B. Objectives and expected achievements

The idea behind the project is to apply dynamic simulation models to organic crop rotations. Before models can be applied to such complex systems as organic crop rotations, they have to be thoroughly validated against experimental data. Such a validation has to ensure that the models are reliable and trustworthy.

The project has three aims:

1. Expand and calibrate models on areas they do not currently have sufficient skill (WP1 to WP3)
2. Validation of the improved and calibrated models on independent experimental data (WP4 and WP5)
3. Scenario analyses of range of management options on different farm types (WP5.2).

The models will be extended in three areas that present models do not handle properly. These three areas, of great importance in organic crop rotations, are undersown crops, root growth and turnover of organic matter. Present experimental data on the two first areas are not of a sufficiently high quality to be used for a calibration, and the current project will thus initiate experiments to collect this kind of data. The obtained data sets will be used not only for model calibration but also as a supplement to other experimental research in organic farming. Existing high quality data on turnover of organic matter will be used to improve the organic matter module in the models.

Validation of the improved models will be performed on independent data to ensure that the models are general and able to make prediction outside their calibration range. Existing data sets from previous and ongoing DARCOF projects will be used for this. These data do, however, not sufficiently

cover the dynamics of grazed grass/clover pastures, which are essential for many organic farming systems. An independent data set will be obtained from two dairy farms on different soil types and focus on grazed clover/grass pasture in WP4.

Scenarios of selected features on three important organic farming systems (vegetables, arable, and dairy farms) will then be performed using the revised models. These scenarios will highlight effects of soil type and crop management, including catch crops, proportion of grass/clover pastures in the rotation, and manure application on selected parameters, i.e. nitrate leaching, crop yields, biodiversity and soil organic matter content. Both short-term and long-term trends will be evaluated.

The main achievement will be model predictions on different organic farming systems, predictions that can help the development of recommendations for organic farmers. This will assist in design of crop rotations, i.e. choice of main crop, catch crops or green manure, animal manure application, management of grass/clover pastures and grazing intensity. Another potential use will be evaluation of environmental effects as nitrate leaching, biodiversity and trends in organic matter contents. It is thus expected that the models in the future will help both to improve organic farming and to support the national administration and political system in evaluating the effects of organic farming on several indicators, including productivity, biodiversity and nitrogen losses to the environment. Last but not least, the models will also be of great value in future organic farming research as they can be used for initial testing of new hypotheses, or help the generation of new hypotheses, thereby contributing to the goal orientation and proper focussing of experimental and empirical research.

C. Midterm results and progress

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

WP1: Adaptation of a model for competition between undersown and main crops.

The two-year field experiment at Foulum has been completed successfully, and all data have been collected in a database. The FASSET competition model has been tested on data from the organic arable rotation, which shows that effects of catch crops on the different soil types can be simulated. However, the testing of the FASSET catch crop model on the WP1 field experiment has been postponed and milestone 4 is thus delayed.

WP2: Improvement of root growth models

A new root model has been proposed and parameters for each crop have been estimated. Simulations have shown that the model can capture some of the root growth patterns of different crops on several soil types. However, scenarios with N-15 have shown that the model might underestimate the effective root depth.

WP3: (including NITMOD DP1)

The calibration tool ("CN-TOOL") is completed, and formed the basis of the work in WP3. This tool is coupled to a database and optimisation module. The database utilised to our knowledge represents the largest existing assembly of field- and laboratory experiments concerning turnover of organic matter. Some of the data sets originally planned for inclusion were discarded due to various reasons. For example it turned out that data-sets including dynamic development of mineral N must have accompanying CO₂ measurements in order to optimise parameters with acceptable confidence intervals. Both for this reason, and the desire to include as many data sets as possible, we included experiments well beyond the number originally planned in the application. Besides comprehensive soil and treatment information, the measurements include the following, which all can be simulated by the CN-TOOL model complex: organic C, organic N, CO₂, NO₃, NH₄, total mineral N, ¹⁵N in various pools, ¹⁴C total and in various pools, microbial C and ¹⁴C, microbial N and ¹⁵N. Utilising this number of experiments, containing all these types of variables is unique in the context of SOM model development. The ¹⁴C analyses from Aarhus University turned out to be excellent data, which might lead to re-assessment of fundamental assumptions underlying parameters in many SOM models. The data clearly indicate that the carbon input level at bare fallow is 5 - 10 times larger than previously as-

sumed, and makes it likely that ^{14}C developments hitherto considered unexplainable errors (Jenkinson & Coleman, 1994, *Eur. J. Soil Sci.*, p. 167-174), are simply consequences of this large input level.

The challenge of constructing a satisfactory model on the one hand has delayed the work significantly, compared to the original plan. On the other hand this process has resulted in many new insights in both actual processes and problems related to their modelling.

The model development of WP3 is now completed, and has resulted in a new SOM model, which yields generally excellent simulations of long-term field experiments, and generally good to acceptable simulations of short-term laboratory experiments (Petersen *et al.*, 2002b, submitted). It is developed on the basis of a data set of a magnitude larger than other SOM models, and is the first model, which fulfils all of the following criteria: 1) parameterisation by extensive use of statistically based methods, including confidence intervals for parameters, 2) use of *in situ* data from several countries and sites, 3) integration of short- and long-term modelling capabilities, 4) extensive use of C and N isotope measurements for development.

During this reporting period, the developed model CN-SIM was successfully implemented in the model complexes DAISY and FASSET, and these model complexes now form the basis of extensive simulations of undertaken experiments as well as scenarios.

WP4

Two sites, one on sandy soil (Brørup) and one on loamy sand (Assentoft), including grazed grass-clover in rotation on dairy farms have been selected for detailed measurements of a large number of parameters. On each site a grass-clover field has been selected and this field has been split in two giving the following two rotations, which are used for measurements.

| Field | 2000 | 2001 | 2002 |
|-------|--------------|---------------|---------------|
| 1 | grass-clover | spring barley | spring barley |
| 2 | grass-clover | grass-clover | spring barley |

The cereal fields were split into three plots at each site, two plots are given manure in either normal or double normal rate and one is not given manure. The nitrate leaching is only measured in the plot, which has been given normal manure rate. The measurement programme has been set up in collaboration with the DINO project under DARCOF-II. This measurement programme can be outlined as:

- *General farm data.* The feed production, feed use and production of milk, meat and manure at the farm level is recorded.
- *Manure.* Amount and quality of applied manure.
- *Soil characterisation.* Soil profiles were characterised in spring 2001, including soil texture, soil water retention and N and C content.
- *Climate.* A weather station is placed at each site.
- *Soil mineral nitrogen and microbial biomass.* Soil samples from the soil profile 0-100 cm have been collected for determination of mineral N. Soil samples from the soil profile 0-100 cm have been collected for determination of microbial biomass by chloroform fumigation.
- *Below-ground and above-ground biomass in grass-clover.* Samples for root and grass determination (dry matter, total C and N and lignin) have been collected from the grass sward of field 1 just before ploughing in March 2001, and of field 2 in the autumn 2001 and before ploughing in April 2002.
- *Above-ground crop biomass and yield in cereals.* Samples of above ground biomass in the cereals in each of the three manure treatments were taken twice during the growing season and at harvest. Grain yield and nitrogen content was measured.
- *Earthworms.* Samples of earthworms have been taken three times during each season. The number of earthworms is relatively low (<150 m⁻²).
- *Nitrate leaching.* Soil water sampling stations were established at each field in December 2000 – January 2001. Each sampling station consists of 12 suction cups installed at a depth of 100 cm and covering an area of approximately 100 m². At field 2 additional suction cups were installed in June 2001 because the grass growth did not recover sufficiently after the installation of the sampling stations in the winter. Water samples have been taken every second week. Samples from

the individual suction cups are analysed for nitrate-N, whereas pooled samples from each station are analysed for $\text{NH}_4\text{-N}$ and total-N. Pooled samples are also analysed for ortho-P and K as an indicator of preferential flow, and for TOC with the purpose of describing organic matter conversion. Percolation through the root zone has been modelled by means of the EVACROP model. Nitrate leaching is calculated on basis of the modelled percolation and measured N-concentrations in soil water.

- *N-fixation and denitrification (DINOG project)*. N-fixation and nitrous oxide emissions were measured 3-4 times during the season in 2001.

At the loamy soils at Randers the clover-grass ensured a very low nitrate leaching (14 kg N/ha) during the run-off period in 2001/02, whereas conversion of the clover-grass field resulted in a large increase in nitrate leaching (199 kg N/ha) during the same period. At the coarse sandy soils at Brørup with high rainfall there was a considerable nitrate leaching (65 kg N/ha) from the clover-grass field in 2001/02, and conversion of clover-grass also lead to increased leaching (199 kg N/ha) and this high level of nitrate leaching continued in the following season of spring barley (250 kg N/ha). There appeared to be no effect on nitrate leaching of the poor recovery of the clover-grass of field 2 in the spring 2001. The grain yield showed no response to manure application in 2001.

| Location | Field | Grain yield 2001 (t/ha with 85% DM) | | | N leaching (kg N/ha/yr) | |
|-----------|-------|--|-----|-----|----------------------------|---------|
| | | 0 N | 1 N | 2 N | 2001-02 | 2002-03 |
| Brørup | 1 | 5.0 | 4.5 | 4.8 | 192 | 250 |
| | 2 | | | | 65 | 264 |
| Assentoft | 1 | 4.9 | 6.0 | 6.3 | 199 | 68 |
| | 2 | | | | 17 | 92 |

The measurements of leaching have been ended in late spring 2003. The data have been compiled and stored for use with in model validation. A joint refereed paper with the model results is in preparation.

WP5: Whole-model calibration, validation, inter-comparison and scenario analyses

5.1 Model calibration

The work focus of all three partners has in 2003 been focussed on the whole-model calibrations and comparisons.

FASSET

The Fasset model has been tested on the Burrehøjvej experiment, Nutrient Management in Dairy Farming Experiment and the Crop Rotation Experiment. The Burrehøjvej experiment has shown that the model captures some of the residual effects of different grazing systems. The simulation of the initial grass growth was overestimated, which implied a higher leaching after ploughing. The grass model is currently being recalibrated to match observed production values.

The Fasset model has also been tested on the Nutrient Management in Dairy Farming Experiment. The current model estimates a difference of 10 kg-N/ha in nitrate leaching between the low and high slurry treatments and 6 kg-N/ha difference between the low and high litter treatments. These values are close to the observed values of 8 and 3 kg-N/ha, respectively. In addition the simulated leaching from the different crops are in general within the observed range. However, a detailed analysis of the different crops have shown that some of the crops need to be recalibrated either due to fast nitrate uptake or due to error in total nitrate uptake and distribution between straw and grain. The fast nitrate uptake is a consequence of the new root model from WP2, which has necessitated new root parameters.

The model has also been tested on the Crop Rotation Experiment at Foulum, Flakkebjerg and Jyndevad. The model has shown to be able to capture fundamental differences between treatment with different levels of organic fertilisation and catch crops. However as noted above some of the crop parameters needs to be adjusted to fit the new root model. For example, the simulated winter wheat at

Foulum in 1999 has a too high nitrate uptake rate. This will be adjusted by recalibration of the nitrate uptake rate.

The Daisy model

The work on applying the *Daisy* model to the Burrehøjvej and the Crop Rotation Experiment Jyndevad data, has in 2003 been focused on i) grass clover ley or grazing simulations, ii) the influence of different catch crop module specifications for nitrate concentration and leaching simulations and iii) comparison of the difference between SOM models (default Daisy vs. BIOMOD CN-SIM, see section 5.2).

The simulation of the initial three years with grazing of grass-clover or pure grass has been optimised and the grass-clover crop model works reasonably well for the sites and treatments involved, although the current Daisy crop model for competing intercrops seems somewhat too sensitive to a number of parameters. However, for the purpose of correctly simulating the residual effect of pastures the optimised performance is considered sufficient.

Following the grass-clover incorporation, we have found the temporal pattern of nitrate concentration in soil solution to be highly dependent on the performance of the ryegrass catch crop simulations between the cereal crops. Slight changes in the catch crop modules causes anything from a larger overestimation to a slight underestimation of nitrate concentrations, and work is currently undergoing to further identify how to make more appropriate and robust catch crop modules. This finding highlights the importance of considering all the different submodels of the modelling system, as changing one submodel may affect other sub-models in unintended and unpredictable ways.

The work on applying the *Daisy* model for calibration on the vegetable crop rotation using data from Årslev Experimental station from the period 1996 to 2001 (Thorup-Kristensen, 1999; pers. comm.) has been done in collaboration with Dr. Torsten Müller, Germany and will be continued in the last part of 2003. Data from a full six-course rotation is used with vegetables in three of the fields in the rotation. The work utilises last years calibration work on crop modules for white cabbage and grass-clover.

The food web model. (Now named FieldEco)

The whole model calibration of FieldEco has been carried out on one of the data sets from Burrehøjvej, namely the one with cutting of grass-clover without application of any kind of fertiliser, and the control data set made by Petersen et al. in the FØJO I, project 7 from the Nutrient Management in Dairy Farming Experiment.

The simulation of the Burrehøjvej data-set is rather good. The simulation of the growth of both the clover and the rye grass in the initial three years clover-grass field coincide pretty well with the measurements, especially after the first year of establishment. In the period after the clover-grass the simulation of barley is rather good with a tendency to an underestimation of the biomass the first year. The simulations of the ryegrass in competition with the barley crop works well in two out of three years, with an underestimation of the growth in 1998. However, there is a clear overestimation of the ryegrass growth in fall after harvest of the barley crop. This is most likely due to that the ryegrass allocates resources to overwintering organs (roots) instead of shoot growth. This is not captured by the model for the moment. The comparison of the simulated plant growth and measured data from this data set indicates that FieldEco's simulations of plant competition are well functioning.

Concerning the simulations of the nitrogen in the soil it recently became clear that the lack of a leaching in the model was a problem, because it accumulated nitrogen in the periods without uptake by plants or microorganisms. Therefore a simple leaching model has now been incorporated in FieldEco, and the already programmed depth distribution was activated. The transport of nitrate down through the soil layers was simply made proportional to the precipitation in the "leaching season", which was defined as 1 september to 30 april. This made FieldEco able to simulate leaching and the transport of nitrogen down through the soil, and the performance is rather good when compared with the measured concentrations of nitrogen in the soil in the layers 0 – 25 cm, 26 – 50 cm, 51 – 75 cm and 75 – 100 cm. However, the simulated amounts of nitrogen in the two lower layers are too high compared to measurements in the two last winters. This is also reflected in the simulated leaching, which coincides well with measurements the first year after ploughing but is twice as high the two following years. The simulation of leaching is very sensitive to rooting depth, and switching maximum rooting depth from 50 cm to 100 cm for barley and ryegrass can change this picture. In the latter case the simulated leaching is half the measured value the first year and

fit reasonably the following two years.

In the FØJO I,7 data set there are measurements of the earthworm densities and mineral nitrogen in a period of 1½ years after ploughing of a two year old clover-grass field. The simulations of the earthworm densities of the two most common species, *Aporectodea caliginosa* og *Allolobophora longa*, are rather good for the dry weight, while the numbers show less good fit to data. The data show a peak density of 200 kg N per ha in the plough layer shortly after ploughing, and the model is unable to reach this high, but it shows a peak of about 120 kg N per ha in the entire profile and 70 kg per ha in the top 25 cm layer. A reason for the very high level of nitrogen shortly after ploughing may be lysing of fresh plant cells which releases rather large amounts of readily convertible nitrogen compounds, and this process is presently not included in the food web model.

WP 5.2 Model validation, inter-comparison and scenario analyses

Several intercomparisons of model results have been presented and discussed at the WP5 group meetings during the year (see H). It is clear that although the soil organic matter module have been applied completely identical in the FASSET and the Daisy models, other model differences with respects to soil water, crop dynamics and solute transport make the simulation results very different in a number of cases. This is in particular evident for the difference in soil water models, where Daisy produces significantly less soil water percolation data than the simpler water model in FASSET for the Burrehøjvej site, but similar percolation for both models with the Jyndevad site. However, which percolation result is the correct remains elusive, as it is a problem of the general water balance deficit identified by DHI, GEUS, DMU, DJF and KVL, who have initiated further investigations.

FASSET

Based on the Burrehøjvej experiment different sensitivity analysis will be performed. These will focus on the importance on how the organic matter model is initialised. The will be done by varying the fractions of active (NOM) and inactive (IOM) organic matter and by using different CN ratios of these pools.

Another set of scenarios will be based on the nutrient household experiment. These scenarios assume a simple dairy farm crop rotation and the evaluate the effects to the following different factors:

1. Soil type (JB1 and JB4)
2. Climate (dry and wet)
3. Stocking rate
4. Fertility (low and high by assuming either 1.5% C and 3% C in plough layer)

The last factor will reflect a newly converted organic dairy farm on either arable or an old conventional dairy farm.

A set of scenarios with focus on arable farms will be constructed based on the Crop Rotation Experiment. The concrete crop rotations and different scenarios factors will be chosen in collaboration with another project, which deals with effects of the Danish Action Plans for the Aquatic Environment.

The food web model (FieldEco).

The role of earthworms has been analysed by comparing simulations with and without earthworms in the simulated ecosystem. Simulations have been made that have been based on both the Petersen data and the Burrehøjvej data. The simulations of the Petersen data showed a very weak effect of earthworms on the simulated nitrogen content of the soil, but an effect on the yield of the spring barley. In the simulations without earthworms the harvested biomass of barley was about 10% lower without earthworms. In the simulations of the Burrehøjvej data the effect of excluding earthworms was more marked. Without the earthworms less nitrogen was released in the first year after ploughing and a little more in the following year. The effect on the simulated barley biomass was rather strong with a reduction to about 2/3 at harvest in the first two years after ploughing of the clover grass. The reasons for these differences in the simulations still has to be investigated, but they may be due to different densities due to variation in the population development and stage distributions of the earthworms by the time of ploughing, and different mortality due to tillage. The tillage mortality of *A. caliginosa* was higher in the simulations of the Petersen data simulation than in the Burrehøjvej data simulations.

The Daisy model

The work this year has focussed on testing the whole-model effects of replacing the standard Daisy SOM model with the newly developed CN-SIM. The standard Daisy SOM model has also been revised with recalibrated parameters (but same structure) over the past couple of years, and hence the comparison is made with both the old and new Daisy versions. This comparison has revealed large differences from the CN-SIM model to the old Daisy SOM-ver., but somewhat smaller differences between application of CN-SIM and the new Daisy SOM. Although SOM pool dynamics of individual pools differ between the two, simulations of soil nitrate and crop production show quite similar trends. The work on this comparison will be further extended and published through the last phase of the project. Again, these finding highlights the importance of considering all the different submodels of the modelling system, changing one submodel may affect other sub-models in unintended and unpredictable ways.

The work on applying the *Daisy* model for scenario vegetable crop rotations will extend from the calibration and validation work on data from Årslev Experimental station. This will focus in particular on scenarios testing the importance of catch crop i) rooting depth and ii) placement within the rotation for whole rotation N utilisation and losses. This will be carried out partly within the PhD project of Anders Pedersen and in collaboration with the VegCatch project.

C.2 Fulfilment of deliverables and milestones

| Task | Time schedule according to application | Deviations, if any* |
|---|--|---------------------|
| WP1. Adaptation of a model for competition between undersown crops and main crops. | | |
| Deliverables | | |
| 1. A data set for adaptation of FASSET's simulation of establishment of clover grass | 2001/10 | Delivered |
| 2. A data set for adaptation of FASSET's interspecies competition sub-model | 2002/10 | Delivered |
| 3. A calibrated interspecies competition sub-module of FASSET | 2003/2 | Delivered |
| 4. A paper on modelling competition between main crops and undersown crops | 2003/6 | Postponed 2004/5 |
| Milestones | | |
| 1. Data on establishment of clover/grass ley | 2001/10 | Achieved |
| 2. Preliminary version of undersown crop module for FASSET available | 2002/6 | Achieved |
| 3. Data on growth of catch crops | 2002/10 | Achieved |
| 4. FASSET's interspecies competition sub-model calibrated and tested by use of the experimental data | 2003/2 | Postponed |
| WP2. Improvement of root growth models | | |
| Deliverables | | |
| 1. Data and parameter estimates for root growth of the three species, and the effect of the soil types, to be used in the modelling | 2002/12 | Delivered |
| 2. Validated root growth model for DAISY and FASSET | 2003/03 | Delivered |
| 3. Paper on modelling root growth in relation to crop species and soil types | 2003/06 | Postponed |
| Milestones | | |
| 1. Models calibrated on existing root growth data | 2001/11 | Postponed |

| | | |
|--|--|--------------------------|
| 2. Preliminary version of root growth model available | 2002/03 | Postponed |
| 3. Data on root growth of main crops available | 2002/12 | Achieved |
| 4. Adaptation and testing of root growth model completed | 2003/03 | Postponed |
| 5. WP3 + NITMOD DP1. Parameterisation of the soil organic matter turnover submodules of DAISY and FASSET (New dates taken from NITMOD application) | Time schedule according to application | Deviations, if any* |
| Deliverables | | |
| 1. Database consisting of C/N experiments | 2001/06 | Delivered |
| 2. Poster with preliminary results | 2001/09 | Delivered |
| 3. Paper with analysis of long-term SOC data | 2001/12 | Postponed |
| 4. Paper regarding new C-N model | 2002/03 | Delivered |
| Milestones | | |
| 1. Model structure determined | 2001/08 | Achieved |
| 2. Calibrated C-N model | 2002/01 | Achieved |
| 3. Implementation of new SOM model in DAISY and FASSET | 2002/12 | Achieved |
| WP4. Crop production, nitrogen balance, nitrate leaching and biodiversity in crop rotations on private farms | | |
| Deliverables | | |
| 1. Yearly datasets from two dairy farms for validation of models. These data sets contain both detailed field level data and less detailed farm level data | 05/2001, 05/2002, 05/2003 | Delivered |
| 2. A report on nitrogen turnover on two dairy farms | 10/2003 | Postponed 2004/4 |
| Milestones | | |
| 1. Selection of two farms, establishment of farms as Pilot Farms, installation of field equipment | 09/2000 | Achieved |
| 2. End of measurement campaign | 08/2003 | Achieved |
| WP5. Whole model calibration, validation inter-comparison and scenario analyses | | |
| Deliverables | | |
| 1. Papers on calibration and validation of the models for different crop rotations | 2003/10 | Postponed to spring 2004 |
| 2. A paper on inter-model comparison of the three models for a dairy crop rotation | 2003/12 | Dropped |
| 3. Papers on scenario analyses for three different crop rotation types | 2003/12 | Postponed to spring 2004 |
| 4. A report with tables of results of scenario analyses for use in advisory work | 2003/12 | Postponed to spring 2004 |
| Milestones | | |
| 1. Compilation and set-up of calibration data sets completed. | 2001/10 | Achieved |
| 2. Preliminary whole-model calibration completed. | 2002/04 | Achieved |
| 3. Final whole-model calibration completed. | 2003/04 | Postponed to 2003/12 |
| 4. Model validation runs completed. | 2003/06 | Postponed to 2003/12 |
| 5. Model scenario runs completed | 2003/10 | Postponed to 2004/2 |
| WP6. Parameterisation of rhizodeposition | | |
| Deliverables | | |
| 1. Database with literature data | 2001/11 | Delivered |

| | | |
|--|---------|-----------|
| 2. Crop parameters | 2002/6 | Delivered |
| WP7. Validation and development of a solute-transport model | | |
| Deliverables | | |
| 1. Database with literature data | 2001/11 | Delivered |
| 2. New model with parameters | 2002/10 | Delivered |
| 3. Article or conference poster | 2002/12 | Dropped |
| WP8. Field data on C and N-turnover in organic crop rotations | | |
| Deliverables | | |
| 1. Database with all data for use in modelling | 2002/03 | Delivered |
| 2. Report/article on experimental data | 2002/12 | Delivered |
| Milestones | | |
| 1. Experiments completed | 2001/10 | Achieved |
| 2. Data stored in database for use by modelling | 2002/03 | Achieved |
| 3. Article on experimental data | 2002/12 | Achieved |

* *Deviations are to be further discussed in D*

D. Description of deviations and subsequent adjustments of plans

WP2:

The tasks of formulating a new root model and publication of this model has been transferred to DIAS Department of Horticulture. This was done due to capacity problems, and the to take advantage of the possible positive interactions with the root modelling tasks of the EU project EUROTATE-N to be made at the Department of Horticulture. We want to transfer a part of the funding to 2004, as this delay will allow full utilisation of the interaction with the EUROTATE-N project.

WP3:

This paper includes a model comparison between ROTHC and FASSET. Because a new version of the DAISY SOM model recently has been made (Bruun et al., 2003, Soil Biol. Biochem., p 67-76), this paper is presently being extended with simulations also with this version, in order to be up to date.

WP4:

It was originally planned to publish the results of the field measurements in a report. However, the results are so interesting that an international journal paper is now being planned for 2004.

WP5:

Milestones: Although the work in WP5 progressed almost timely in the first half of 2003, delays in the completion of the last three milestones have been caused by the fact that two central project staff members have been assigned other urgent tasks:

- i) DJF researcher, Jørgen Berntsen has been assigned urgent VMP-III work. This work also involves the application of the revised FASSET-model in the current project and required completion within autumn 2003. However, Jørgen will be able to complete WP5 work in the first half of 2004.
- ii) KVL researcher, Anders Pedersen, received a PhD-fellowship from another FØJO project (VegCatch), an EU project EUROTATE and a SOAR-fellowship which had to commence Sept. 2003. The remaining 4 months work of Anders on WP5 can be postponed until first half of 2004, where he will take leave from his PhD .

Hence we want to apply for an extension of the project into 2004.

As the whole model calibrations and validations will be completed within 2003, it is only the completion of the model scenario work and the publication of the model calibration, validation and scenario work that will be extended into 2004, hence we do not think this will jeopardise the BIOMOD project or the users of our results significantly.

The combination of FieldEco and FASSET simulation programs has not been completed. There are two reasons for this: 1) it turned out that one of the very central structures (named "LinkedList") in FASSET was not accepted by the C++Builder compiler, which is being used for the programming of FieldEco. Therefore, it will be a very large job (out of the scope of this project) to reconstruct the code of either FASSET or FieldEco to suit each other, and 2) priority was given to obtain good simulations with FieldEco itself, because it did not make sense to spend time on merging the code of two models of which one or both did not function properly. Now both models are functioning well, but due to the programming problems mentioned in 1) it is preferable to spend the remaining project time on validation and scenarios.

It was originally planned to make a joint paper on comparison of all three models based on one of the experimental datasets. We have spent quite some time in the project doing model intercomparisons. However, we do not consider these results to be applicable for publication. The reason is that too many different factors and processes vary between the models, and it is difficult to sort out the effects. In stead we are aiming at separate papers that describe the key sensitivities of the individual models.

WP7.

The publication of the new transport model in FASSET were dropped, as an analysis showed that a minor modification of the present transport model was necessary. We decided that this modification wasn't big enough for a separate publication. The modification will be published as part of another paper.

Deliverables: At our project group meeting in August 2003 the following publication plan was agreed upon (responsible authors, deadlines):

- A scientific manuscript on the application of *FieldEco* to the Burrehøjvej and Petersens data (Jørgen Axelsen, 2003/11)
- A scientific manuscript on the application of *FASSET* to Crop Rotation Experiment data of plant production with focus on validation and scenario analyses, (Jørgen Berntsen, Jørgen Olesen and Bjørn M. Petersen, 2003/11)
- A scientific manuscript on the application of *FASSET* to the Burrehøjvej data with focus on the grass-clover sub-model and soil turnover parameters (Jørgen Berntsen 2003/12)
- A scientific manuscript on the application of *FASSET* to the Nutrient Management in Dairy Farming Experiment data with focus on validation and scenario analyses (Jørgen Berntsen 2004/02)
- A scientific manuscript on the application of *Daisy* to the Burrehøjvej data with focus on comparison of SOM models (Lars S. Jensen and Anders Pedersen 2004/05)
- A scientific manuscript on the application of *Daisy* to the vegetable and catch crop rotation data at Årslev, focussed on test and scenarios (Anders Pedersen and Lars S. Jensen 2004/05)
- A scientific manuscript on the application of *FieldEco* to the Crop Rotation Experiment data of plant production with focus on validation and scenario analyses (Jørgen Axelsen, 2004/05)

E. Project publications and other products

1. Articles in international, scientific journals with review procedures

Petersen, B.M., Olesen, J.E. & Heidmann, T. 2002. A flexible tool for simulation of soil carbon turnover. *Ecological Modelling*, 151, 1-14. **(WP3)**

Larsen, T; Schjøning, P and Axelsen, J.A. (*accepted*) The impact of soil structure on euedaphic Collembola. *Applied Soil Ecology* **(WP 5)** (50% financed by this project)

* Larsen, T.; Ravn, H.W. and Axelsen, J.A. (*accepted*). Simplified methods for extraction and quantification of ergosterol from fungi in soil. *Journal of Chromatography A* **(WP 5)** (50% financed by this project)

Petersen, B.M., Berntsen, J., Hansen, S. & Jensen, L.S. 2003a. CN-SIM - a model for the turnover of soil organic matter. I: Long term carbon development. Submitted to *Soil Biol. Biochem.* **(WP 3)**

Petersen, B.M., Jensen, L.S., Berntsen, B., Hansen, S., Pedersen, A., Henriksen, T.M., Sørensen, P. & Trinsoutrot-Gattin, I. 2003b. CN-SIM - a model for the turnover of soil organic matter. II: Short term carbon and nitrogen development. Submitted to *Soil Biol. Biochem.* **(WP 3)**

* Bach, L.; Jørgensen, H.B. and Axelsen, J.A. (in prep). Effect of collembolan grazing on interspecific competition between microfungi, decomposition of organic matter and bio-available nitrogen. (*almost ready for submission*) **(WP 5)** (50% financed by this project)

* Bach, L.; Jørgensen, H.B. and Axelsen, J.A. (in prep). Effect of different levels of collembolan grazing on interspecific competition between microfungi, decomposition of organic matter and bio-availability of nitrogen.) **(WP 5)** (50% financed by this project)

** Müller T., Thorup-Kristensen K., Magid J., Jensen L.S. and Hansen S. Catch Crops in Organic Farming Systems without Livestock Husbandry - Simulations with the DAISY model. First draft. **(WP 5)**

*Berntsen, J., Hauggard-Nielsen, H., Olesen, J.E., Petersen, B.M., Jensen, E.S. and Thomsen, A. Modelling dry matter production and resource use in intercrops of pea and barley. *Field Crops Research* (submitted).

Vinther, F.P., Hansen, E.M. & Olesen, J.E.. Effects of plant residues on microbial activity including field CO₂ and N₂O fluxes and N mineralisation in unfertilised crop rotations. *Nutrient Cycling in Agroecosystems* (*in press*). **(WP8)**.

2. Papers presented at congresses, symposiums, etc.

1. Petersen, B.M. 2001. Using C-Tool to simulate soil carbon and radiocarbon development. In: COST 627. Carbon storage in European Grasslands. Danish Institute of Agricultural Sciences, Research Centre Foulum, Denmark. pp 22. **(WP3)**

2. Pedersen A., Bruun S., Jensen L.S. and Hansen S. 2001. Simulating Soil Organic Matter Transformations with the New Implementation of the Daisy Model. Poster at 11th Nitrogen Workshop, 9-12 September 2001, Reims, France **(WP3)**

3. Vinther, F.P., Hansen, E.M. & Olesen, J.E. (2002). Relationship between crop rotation and microbial biomass and activity including field CO₂ and N₂O fluxes and N mineralisation. NJF Seminar 342: Agricultural soils and greenhouse gasses in cool-temperate climate. **(WP8)**

4. Petersen, B.M. & Berntsen, J., 2002. Omsætning i jordpuljen på forskellige bedriftstyper. Temadag arrangeret af Afd. for Jordbrugssystemer 24. april 2002. Forskningscenter Foulum. Intern rapport nr. 157: 13-24. **(WP3)**

5. ** Müller T., Jensen L.S., Magid J., Nielsen N.E., Hansen S., Thorup-Kristensen K. (2002) Catch crops in organic farming systems without livestock husbandry – model simulations. In: Transactions of 17th World Congress of Soil Science, Bangkok, Thailand. p 830.1-830.9. **(WP5)** (25% financed by this project)

6. Petersen, B.M., Berntsen, J. & Jensen, L.S. & Hansen, S. 2003. Modelling long term carbon and radiocarbon development. Paper for the 12. N workshop in Exeter. **(WP3)**

7. Petersen, B.M. Jensen, L.S., Berntsen, Hansen, S. & Pedersen, A. 2003. Modelling short term carbon and nitrogen development. Paper for the 12. N workshop in Exeter. **(WP3)**

8. Berntsen, J., Olesen, J.E., Petersen, B.M., Eriksen, J., Askegaard, M.. 2003. Simulation of nitrate leaching from an organic dairy crop rotation with different manure types and loads. Paper for the 12. N workshop in Exeter. (WP5)

3. Reports, articles in agricultural journals, etc.

4. Oral presentations, public meetings, field days, etc.

1. Petersen, B.M. & Berntsen, J., 2002. Omsætning i jordpuljen på forskellige bedriftstyper. Temadag arrangeret af Afd. for Jordbrugssystemer 24. april 2002. Forskningscenter Foulum. Intern rapport nr. 157: 13-24. (WP3)

F. Scientific education

G. National and international cooperation

Dr. Torsten Müller, Dept. of Soil Biology and Plant Nutrition, Faculty of Ecological Agricultural Sciences, University of Kassel (e-mail: tmuller@wiz.uni-lassel.de). Collaboration on applying the Daisy model to vegetable crop rotations (WP5).

H. Critical reflection on the project

The major focal point for this project has been the improvement of both our understanding and predictive capability regarding the dynamics of nitrogen, crop production and soil biodiversity. Several difficulties in integrating all these aspects in WP5 have been encountered during the first half of the project as reported in the status report of 2002. In 2003 the major difficulties have been with the implementation of the soil organic matter module developed in WP3 into Daisy and FASSET; the whole model calibrations revealed that many refinements and adjustments still needed to be done. As described in C1, it also became evident that whilst the soil organic matter module has a bearing influence on the simulation results, other submodules, in particular the crop modules (pasture model, main crop model, catch crop model) and the soil solute transport model, have an even larger bearing on the simulation results of nitrate leaching. We have tried to unravel these differences and their causes, and this work is still on-going and will be included in the publication of results.

To ensure successful completion of the project, the following time schedule was set up in 2002 for the remaining part of the project. Furthermore as the result of the delays described under D, we apply for extension of the project into 2004. We have indicated the fulfilment and deviations from the earlier plan below, and have added some deadlines for the deliverables still to be completed in the extended period of 2004:

| 2002: | Activity | Status / deviations |
|--------------|--|------------------------------|
| 3.-4. Sept. | First version of Burrehøjvej data simulations (included in status report 2002) | <i>Completed</i> |
| 1. Oct. | Deadline for WP3 – SOM module adjustments for FASSET/Daisy | <i>Completed early 2003.</i> |
| 15. Oct. | Additional data from crop rotation experiment (CRE) | <i>Completed</i> |

| | | |
|--------------|--|---|
| | Jyndevad to be available in the database | |
| 1. Nov. | Dynamic coupling of FASSET and the Food Web model completed | <i>Initiated, but not completed until april 2003</i> |
| | Second version of Burrehøjvej data simulations completed | Completed |
| | Project group meeting | <i>Held Nov. 2002, DMU-Silkeborg</i> |
| 15. Nov. | Additional data from the old grass-clover experiment (nutrient balance, DARCOF project IV EXUNIT) at Foulum to be available in the database | <i>Completed</i> |
| 2003 | | |
| January | Internal calibration and validation of the Food Web model to be completed. | <i>Completed mid 2003</i> |
| | First version of CRE, EXUNIT and Årslev data simulations completed | <i>Completed, but not until mid 2002 due to WP3 delay</i> |
| | Project group meeting on these, and brainstorm and planning of scenario analyses (WP5.2). | <i>Held March 2003 DJF-Foulum</i> |
| March | Work on scenario analyses (WP5.2) initiated | <i>Discussed at meeting April 2003 KVL-Taastrup</i> |
| April | Second version of CRE, EXUNIT and Årslev data simulations completed | Completed, but not until Aug. 2003. Some work still remains. |
| | Scenario analyses | <i>Initiated May 2003</i> |
| | Plan for publication of model comparison | <i>Agreed at meeting KVL-Taastrup</i> |
| | Project group meeting | <i>Held April 2003 KVL-Taastrup</i> |
| May | Measurements from WP4 to be completed and available in the database | <i>Completed, but not until autumn 2003</i> |
| August | First version of WP4 simulations for full-scale model validation | <i>Delayed, due to late completion of data and to other obligations of WP5 staff, see D and below</i> |
| | Project meeting for all BIOMOD-partners | <i>Held Aug. 2003</i> |
| Autumn | Second version of WP4 simulations | <i>Delayed, due to late completion of data and to other obligations of WP5 staff, see D.</i> |
| | Publication | Expected 2003/12 Scientific publication delayed, see D and below. National publication as necessary for VMPIII |
| 2004 | | |
| April | Model scenario runs completed | |
| June | Scientific publications drafted and submitted | |
| Nov. | International research workshop organised by the BIOMOD and VegCatch projects in collaboration. | |
| | Working title of the workshop is "Nutrient dynamics, crop production and biodiversity of organic crop rotations". The workshop will primarily focus on understanding of the dynamics of organic crop rotations and the interactions between different components, include trade-offs between the effect of various management options on the functional behaviour of the different elements in the system, including nutrients, crop production, weeds and soil fauna. | |

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 | Total |
|----------------------|-------------------------|---------------------------|-------|------|--------|
| Man-months | 147,82 | 29,32 | 15,04 | | 192,18 |
| Scientific personnel | 82,24 | 23,82 | 15,01 | | 121,07 |
| Technical personnel | 65,58 | 5,5 | 0,03 | | 71,11 |

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|--------------------------------------|-------------------------|---------------------------|-------|------|---------------|
| Salaries | (4.632) 4686 | 1267 | 571 | | (6.470) 6524 |
| Scientific personnel | (3.053) 3098 | 1107 | 563 | | (4.723) 4768 |
| Technical personnel | (1.579) 1588 | 160 | 8 | | (1.747) 1756 |
| Other operational costs | (789) 803 | 129 | 5 | | (923) 937 |
| Equipment | | | | | |
| Others (please specify) | 25 | 5 | 5 | | 35 |
| Direct costs | (5.447) 5515 | 1401 | 581 | | (7.429) 7497 |
| Indirect costs (20% of direct costs) | (1.090) 1104 | 278,4 | 117,6 | | (1.486) 1500 |
| Total | (6.537) 6619 | 1679,4 | 698,6 | | (8.915) 8997 |

Comments:

Consumption before 2003 is 68 kkr. lower than expected in the report concerning 2002. DJF has transferred 50 kkr. (incl. overhead) on other operational costs from 2002 to 2003 and 2004. NERI-FEVØ has transferred 26 kkr. (incl. overhead) on other operational costs from 2002 to 2003 and 2004 while the consumption for NERI-TERI was 8 kkr. higher than expected.

Concerning the total amount for the project. The consumption for NERI-TERI before 2003 was 82 kkr. higher than the budget which is the reason why the total amount is higher than the original budget.

Amounts in () show the amounts being covered by DFFE.

9. Signatures and stamps

| Name | Institute | Date | Signature |
|-----------------------------------|--|----------|-----------|
| Head of project Jørgen Axelsen | National Environmental Research Institute | 20-10-03 | |

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

Institute: National Environmental Research Institute

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|----------------------|-------------------------|---------------------------|------|------|-------|
| Man-months | 49,62 | 11,32 | 3,54 | | 64,48 |
| Scientific personnel | 23,54 | 5,82 | 3,51 | | 32,87 |
| Technical personnel | 26,08 | 5,5 | 0,03 | | 31,61 |

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|---|-------------------------|---------------------------|-------|------|--------------|
| Salaries | (1.484) 1538 | 350 | 170 | | (2.004) 2058 |
| Scientific personnel | (868) 913 | 225 | 162 | | (1.255) 1300 |
| Technical personnel | (616) 625 | 125 | 8 | | (749) 758 |
| Other operational costs | (313) 327 | 37 | | | (350) 364 |
| Equipment | | | | | |
| Others (please specify) | | | | | |
| Direct costs | (1.797) 1865 | 387 | 170 | | (2.354) 2422 |
| Indirect costs (20% of direct costs) | (360) 374 | 75,4 | 35,6 | | (471) 485 |
| Total | (2.157) 2239 | 462,4 | 205,6 | | (2.825) 2907 |

Institute: Danish Inst. of Agricultural Science

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|----------------------|-------------------------|---------------------------|------|------|-------|
| Man-months | 82,2 | 14 | 7,5 | | 103,7 |
| Scientific personnel | 42,7 | 14 | 7,5 | | 64,2 |
| Technical personnel | 39,5 | | | | 39,5 |

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|--------------------------------------|-------------------------|---------------------------|------|------|-------|
| Salaries | 2466 | 798 | 281 | | 3545 |
| Scientific personnel | 1503 | 763 | 281 | | 2547 |
| Technical personnel | 963 | 35 | | | 998 |
| Other operational costs | 437 | 87 | | | 524 |
| Equipment | | | | | |
| Others (please specify) | | | | | |
| Direct costs | 2904 | 885 | 281 | | 4070 |
| Indirect costs (20% of direct costs) | 581 | 177 | 56 | | 814 |
| Total | 3485 | 1062 | 337 | | 4884 |

Name of Institute Royal Veterinary and Agricultural University, Department of Agricultural Sciences

| Year: | Consumption before 2002 | 2002 | Expected consumption 2003 | 2004* | Total |
|----------------------|-------------------------|------|---------------------------|-------|-------|
| Man-months | 6 | 10 | 4 | 4 | 24 |
| Scientific personnel | 6 | 10 | 4 | 4 | 24 |
| Technical personnel | | | | | |

| Year: | Consumption before 2002 | 2002 | Expected consumption 2003 | 2004* | Total |
|--------------------------------------|-------------------------|------------|---------------------------|------------|-------------|
| Salaries | 262 | 420 | 119 | 120 | 921 |
| Scientific personnel | 262 | 420 | 119 | 120 | 921 |
| Technical personnel | 0 | 0 | 0 | 0 | 0 |
| Other operational costs | 29 | 10 | 5 | 5 | 49 |
| Equipment | 0 | 0 | 0 | 0 | 0 |
| Others (travel) | 15 | 10 | 5 | 5 | 35 |
| Direct costs | 306 | 440 | 129 | 130 | 1005 |
| Indirect costs (20% of direct costs) | 61 | 88 | 26 | 26 | 201 |
| Total | 367 | 528 | 155 | 156 | 1206 |

B. Budget for each participating department (1.000 Dkr)

Name of Institute and department: DMU -FEVØ

| Year: | Consumption before 2000 | 2000 | 2001 | 2002 | 2003 | 2004 | Total |
|----------------------|-------------------------|------|------|------|------|------|-------|
| Man-months | | 2 | 12,5 | 11,2 | 6,1 | 2,5 | 34,3 |
| Scientific personnel | | 2 | 3 | 1,2 | 0,6 | 2,5 | 9,3 |
| Technical personnel | | 0 | 9,5 | 10 | 5,5 | | 25 |

| Year: | Consumption before 2000 | Consumption 2000 | Consumption 2001 | Consumption 2002 | budget 2003 | budget 2004 | Total |
|--------------------------------------|-------------------------|------------------|------------------|------------------|-------------|-------------|-------|
| Salaries | | 65 | 331 | 330 | 152 | 113 | 991 |
| Scientific personnel | | 65 | 121 | 50 | 27 | 113 | 376 |
| Technical personnel | | 0 | 210 | 280 | 125 | | 615 |
| Other operational costs | | 90 | 110 | 51 | 17 | | 268 |
| Equipment | | | | | | | |
| Others (please specify) | | | | | | | |
| Direct costs | | 155 | 441 | 381 | 169 | 113 | 1259 |
| Indirect costs (20% of direct costs) | | 31 | 89 | 76 | 32,4 | 23,6 | 252 |
| Total | | 186 | 530 | 457 | 201,4 | 136,6 | 1511 |

Comments:

For 2004 we request to transfer 113.000 kr. to scientific personnel for analysis and publication of results

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

| Year: | Con- sumption before 2002 | 2002 | Expected consump- tion 2003 | 2004* | Total |
|----------------------|------------------------------------|------|--------------------------------------|-------|-------|
| Man-months | 6 | 10 | 4 | 4 | 24 |
| Scientific personnel | 6 | 10 | 4 | 4 | 24 |
| Technical personnel | | | | | |

| Year: | Con- sumption before 2002 | 2002 | Expected consump- tion 2003 | 2004* | Total |
|---|------------------------------------|------------|--------------------------------------|------------|-------------|
| Salaries | 262 | 420 | 119 | 120 | 921 |
| Scientific personnel | 262 | 420 | 119 | 120 | 921 |
| Technical personnel | 0 | 0 | 0 | 0 | 0 |
| Other operational costs | 29 | 10 | 5 | 5 | 49 |
| Equipment | 0 | 0 | 0 | 0 | 0 |
| Others (travel) | 15 | 10 | 5 | 5 | 35 |
| Direct costs | 306 | 440 | 129 | 130 | 1005 |
| Indirect costs (20% of direct costs) | 61 | 88 | 26 | 26 | 201 |
| Total | 367 | 528 | 155 | 156 | 1206 |

Comments:

WP3 & 5 (KVL):

The budget was revised in 2001 with the inclusion of funding from the NITMOD project (96 kkr). Furthermore, transfer of 95 kkr from 2000 to 2001, and 225 kkr from 2001 to 2002 has also been included. The accumulated budget for 2002 was consumed that year.

***: The budget for 2003 has due to the application for extension been divided equally between 2003 and 2004.**

Name of Institute and department: DJF – Department of Agroecology

| Year: | Consumption before 2003 | Expected 2003 | 2004 | 2005 | | Total |
|----------------------|-------------------------|---------------|------|------|--|-------|
| Man-months | | | | | | |
| Scientific personnel | 40.2 | 10 | 5.5 | | | 56 |
| Technical personnel | 35 | 0 | 0 | | | 35 |

| Year: | Consumption before 2003 | Expected 2003 | 2004 | 2005 | | Total |
|--------------------------------------|-------------------------|---------------|------|------|--|-------|
| Salaries | | | | | | |
| Scientific personnel | 1389 | 564 | 181 | | | 2134 |
| Technical personnel | 846 | 29 | 0 | | | 875 |
| Other operational costs | 395 | 84 | 0 | | | 479 |
| Equipment | | | | | | |
| Others (please specify) | | | | | | |
| Direct costs | 2631 | 677 | 181 | | | 3489 |
| Indirect costs (20% of direct costs) | 526 | 136 | 36 | | | 698 |
| Total | 3157 | 813 | 217 | | | 4187 |

Comments:

The old JBS and PVJ departments have been joined, and the budget thus reflects this.

Kr. 180.000 have been transferred from DIAS Department of Soil and Plant Physiology to Department of Horticulture for tasks on root modelling

For 2004 we request a transfer of 217.051 kr. corresponding to 5.5 VIP month.

Name of Institute and department: Department of Horticulture, Danish Inst. of Agricultural Science

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|----------------------|-------------------------|---------------------------|------|------|-------|
| Man-months | 7 | 4 | 2 | | 13 |
| Scientific personnel | 2,5 | 4 | 2 | | 8,5 |
| Technical personnel | 4,5 | | | | 4,5 |

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|--------------------------------------|-------------------------|---------------------------|------|------|-------|
| Salaries | 231 | 205 | 100 | | 536 |
| Scientific personnel | 114 | 199 | 100 | | 413 |
| Technical personnel | 117 | 6 | | | 123 |
| Other operational costs | 42 | 3 | | | 45 |
| Equipment | | | | | |
| Others (please specify) | | | | | |
| Direct costs | 273 | 208 | 100 | | 581 |
| Indirect costs (20% of direct costs) | 55 | 41 | 20 | | 116 |
| Total | 328 | 249 | 120 | | 697 |

Comments: Kr. 180.000 have been transferred from DIAS Department of Soil and Plant Physiology to Department of Horticulture for tasks on root modelling. We want to transfer kr. 120.000 to year 2004 to finish the publication of this work.

Name of Institute and department: National Environmental Research Institute - TERI

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|----------------------|-------------------------|---------------------------|------|------|-------|
| Man-months | 23.92 | 5.22 | 1.04 | | 30.18 |
| Scientific personnel | 17.34 | 5.22 | 1.01 | | 23.57 |
| Technical personnel | 6.58 | | 0.03 | | 6.61 |

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|--------------------------------------|-------------------------|---------------------------|------|------|---------------|
| Salaries | (758) 812 | 198 | 57 | | (1.013)1.067 |
| Scientific personnel | (632) 677 | 198 | 49 | | (879) 924 |
| Technical personnel | (126) 135 | | 8 | | (134) 143 |
| Other operational costs | (62) 76 | 20 | 0 | | (82) 96 |
| Equipment | | | | | |
| Others (please specify) | | | | | |
| Direct costs | (820) 888 | 218 | 57 | | (1.095) 1.163 |
| Indirect costs (20% of direct costs) | (164) 178 | 43 | 12 | | (219) 233 |
| Total | (984) 1.066 | 261 | 69 | | (1.314) 1.396 |

Comments:

The consumption before 2003 was 82 kkr. higher than the budget which is the reason why the total amount is 1.396 and not 1.314.

For 2004 we request to transfer 69 kkr. corresponding to 1.04 months.