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

IV. FØJOII-23 Experimental units for research in organic farming systems (EXUNIT)
IV.2. FØJOII-42 Communication based on experimental units for organic farming (EXUNIT-2)

---

3. Head of project

Senior scientist Jørgen E. Olesen
Danish Institute of Agricultural Sciences
Department of Crop Physiology and Soil Science
Research Centre Foulum
P.O. Box 50
DK-8830 Tjele
Tel. +45 89991659
Fax. +45 89991619
E-mail: JorgenE.Olesen@agrsci.dk

---

4. Participating institutes

Danmarks JordbrugsForskning
Forskningscenter Foulum
Postboks 50
8830 Tjele
Tlf. 89991900
Fax. 89991919
E-mail: djf@agrsci.dk

KVL
Forsøgsgårdene KVL
Højbakkegård Alle 30
2630 Taastrup
Tlf. 35283526
Fax. 35283580
E-mail: halj@kvl.dk

Grønt Center
Maribovej 9
4960 Holeby
Tlf. 54607000
Fax. 54606905
E-mail: mail@greencenter.dk

Landbrugets Rådgivningscenter
Udkærsvej 15, Skejby
8200 Århus N
Tlf. 87405000
Fax. 87405010

5. Other project staff

Forsker Margrethe Askegaard (MA), Afd. for Plantevækst og Jord, Postboks 50, 8830 Tjele, Tlf. 89991702, Fax. 89991719, E-mail: Margrethe.Askegaard@agrsci.dk.

Forskningsprofessor Bent T. Christensen (BTC), Afd. for Plantevækst og Jord, Postboks 50, 8830 Tjele, Tlf. 89991709, Fax. 89991719, E-mail: BentT.Christensen@agrsci.dk.

Seniorforsker Jørgen Eriksen (JE), Afd. for Plantevækst og Jord, Postboks 50, 8830 Tjele, Tlf. 89991870, Fax. 89991719, E-mail: Jorgen.Eriksen@agrsci.dk.

Seniorforsker Hanne Lindhard Pedersen (HLP), Afd. for Prydplanter og Vegetabilske Fødevarer, Forskningscenter Årslev, Kirstinebjergvej 10, Postboks 102, 5792, Årslev, Tlf. 63904171, Fax. 63904396, E-mail: Hanne.Lindhard@agrsci.dk.

Driftschef Hanne L. Jakobsen (HLJ), Forsøgsgårdene KVL, Højbakkegård Alle 30, 2630 Taastrup, Tlf. 35283526, Fax. 35283580, E-mail: halj@kvl.dk

Seniorforsker Kristian Kristensen (KK), Afd. for Jordbrugssystemer, Postboks 50, 8830 Tjele, Tlf. 89991209, Fax. 89991200, E-mail: Kristian.Kristensen@agrsci.dk.

Videnskabelig leder Frank W. Oudshoorn, Rugballegård Forsøgsstation, Postboks 536, 8700 Horsens, Tlf. 76296106, Fax. 76296102, E-mail: Frank.Oudshoorn@agrsci.dk.

Professor John R. Porter (JRP), KVL, Agroøkologi, Agrovej 10, 2630 Tåstrup, Tlf. 35283377, Fax. 35282175, E-mail: jrp@kvl.dk.

Forsker Ilse A. Rasmussen (IAR), Afd. for Plantebeskyttelse, Forskningscenter Flakkebjerg, 4200 Slagelse, Tlf. 58113394, Fax. 58113301, E-mail: IlseA.Rasmussen@agrsci.dk

Sektionsleder Michael Tersbøl, Landskontoret for Planteavl, Landbrugets Rådgivningscenter, Udkærsvej 15, Skejby, 8200 Århus N, Tlf. 87405445, Fax. 87405010, E-mail: mit@lr.dk

Forskningsleder Kristian Thorup-Kristensen (KTK), Afd. for Prydplanter og Vegetabil-

ske Fødevarer, Forskningscenter Årslev, Kirstinebjergvej 10, Postboks 102, 5792, Årslev, Tlf. 63904128, Fax. 63904394, E-mail: Kristan.ThorupKristensen@agrsci.dk

6. Project period (month, year)

EXUNIT: 2000 - 2004
EXUNIT-2: 2002 - 2005

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

A. Project summary

A number of field experimental units were established in 1996 as part of the joint effort on organic farming research in Denmark coordinated by DARCOF. These units primarily consisted of field experimental sites at Flakkebjerg, Foulum, Jyndevad, Årslev, Askov and KVL-Taastrup, and the long-term crop rotation experiments at Jyndevad, Foulum, Flakkebjerg og Holeby. The organic farming research station, Rugballegård, has also been available for this research. These experimental units cover all major organic farming practices and soil types in Denmark.

The aims of the experimental units for research in organic farming systems are three-fold:
1. To describe long-term effects of organic farming practices and crop rotations.
2. To function as workshop facilities for other, more specific research projects.
3. To assist in communication and dissemination of the results of research on organic farming.

The activities in the project is divided into three categories:
1. Dedicated workshop areas. This includes organic crop rotations with 1-2 ha fields, but no experimental treatments within the fields. The main role of these areas is to function as sites for more detailed experimentation. The rotations at these sites will be adjusted to include more arable crops and a higher and more diversified use of catch crops.
2. Long-term field experiments with crop rotations, catch crops and various fertiliser levels, which also function as workshop areas for other dedicated experiments. Yields and nutrient leaching is measured in all these experiments.

   The crop rotation experiment includes three factors in a factorial design with two replicates: A) fraction of grass-clover and pulses in the rotation (crop rotation), B) catch crop (without or with catch crop), and C) fertiliser (without or with animal manure applied as slurry). This experiment is conducted at four locations, representing different soil types and climate regions.

   An experiment on nutrient cycling in organic dairy farming crop rotation is conducted at Foulum. The experiment includes treatments with two levels of animal manure and two types of animal manure in a factorial design. The crop rotation of this experiment will be modified to study more closely the nitrogen cycling in the experiment as affected by both grass-clover crops and manure type and level.

   The third experiment is also located at Foulum, but includes different types and management of grazed grass and grass-clover pastures. This experiment will be used to investigate more closely the effect of proportion of pasture in the rotation for yields and nutrient use.
3. Demonstration and communication. The basic activities include field days, radio and TV interviews and papers in farmers journals. In addition several two-day seminars will be organised every year at the experimental sites aimed primarily at organic advisors. An advisory committee will aid the project group with respect to change in crop rotations and management of the experimental sites and with respect to demonstration activities.

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

EXUNIT

WP No	Work package title	Responsible participant	Budget 1000 DKK	Start	End	Deliverable No
1	Project coordination	JEO	251	2000/01	2004/12	D1-D4
2	Workshop areas at Jyndevad, Foulum, Årslev, Flakkebjerg and KVL-Taastrup	JEO, IAR, KTK, HLP, HLJ, JRP	2664	2000/01	2002/12	D1,D4,D5
3	Long-term fertilisation experiment	BTC	250	2000/01	2002/12	D1,D4
4	Workshop area on grazing intensity and residual effects of pastures	JE	407	2000/01	2002/12	D1,D4
5	Experiment on nutrient management in organic dairy farming	MA, JE	627	2000/01	2002/12	D1,D4, D6-D7
6	Crop rotation experiment	JEO, MA, IAR	8476	2000/01	2004/03	D1,D4, D8-D11
7	Organic experimental farm Rugballegård	FWO	2345	2000/01	2004/12	D1,D4

EXUNIT-2

WP No	Work package title	Responsible participant	Budget 1000 DKK	Start	End	Deliverable No
1	Dedicated workshop areas	JEO, IAR, KTK, HLJ	1200	2003/01	2004/12	1,2,4,7
2	Experiments as workshop areas	JEO, JE, MA, IAR	3080	2002/01	2005/03	1,2,4,7
3	Demonstration and communication	MT	720	2002/01	2004/12	1-6

B. Objectives and expected achievements

The aims of the experimental units for research in organic farming systems are three-fold:
1. To describe long-term effects of organic farming practices and crop rotations.
2. To function as workshop facilities for other, more specific research projects.
3. To assist in communication and dissemination of the results of research on organic farming.

The range of experimental sites covered by the project will provide information for all major organic farming practices and soil types in Denmark.

C. Midterm results and progress

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

C.1.1 Dedicated workshop units

The experimental units all have different structures and roles for the research on organic farming in Denmark. Some of the research areas consist of crop rotations placed on traditional agricultural research stations on different soil types and they represent different farm types, including dairy farms (Foulum, Jyndevad and KVL), plant and pig production (Flakkebjeg) and vegetable crop production (Årslev). These sites vary in climatic and soil conditions. Each course of the rotation is represented with an area of about 1-2 ha. This allows for factorial field experiments within each field while at the same time maintaining a fixed rotation.
The ÅR2 experimental area represents an experimental area for perennial fruit crops and berries. Soil nutrient status and occurrence of weeds, pests and diseases are monitored.

The CFE experiment at KVL represents fields of different lengths separated by hedges for energy production. Each field has a crop rotation and has room for experiments and studies.

The organic experimental station, Rugballegaard, is the only facility where full scale production can be registered in relation to live stock grazing of cattle and pigs in different crop rotation systems under organically certified conditions.

Rugballegaard, the organic experimental station

The organic experimental station, Rugballegaard, is mainly used for experiments with livestock (cattle and pigs) and to study the interactions between crops and livestock. The experimental station has fields of different sizes, though never less than three ha´s. In 1996 three crop rotations representing different farming systems were established on an area of 140 ha (Table 1). The production of crops and livestock is recorded and nutrient balances are calculated at the field and farm levels. The layout of the fields does not allow direct comparisons between the systems. However, the crop production results indicate slightly higher yields of the mixed system (Table 2).

The three systems will be continued with minor changes.

Table 1. Characteristics of the three systems at Rugballegaard.

System	Area with grass-clover (%)	Area with cereals (%)	Feed import (%)	Livestock density (LU ha^{-1})	Manure import (kg N ha^{-1})	Total area (ha)
Dairy	60	40	10	1.1	0	34.9
Pigs	20	80	25	0.7	45	30.9
Dairy/pigs	40	60	15	1.0	0	71.0

Table 2. Five years results from three systems, hkg of DM/ha

	1997	1998	1999	2000	2001	Mean
Pig system						
Average of cereals/peas and lupin	41	40	42	42	30	39
Average of roughage	62	21	18	46	47	43
Total (average of cereals, roughage, peas/lupin)	49	36	38	43	35	40
Dairy system						
Average of cereals/peas and lupin	34	35	36	50	36	39
Average of roughage	74	62	84	59	74	71
Total (average of cereals, roughage, peas/lupin)	51	52	73	56	62	59
Mixed system						
Average of cereals/peas and lupine	43	36	42	51	35	41
Average of roughage	83	83	90	70	65	79
Total (average of cereals, roughage, peas/lupin)	71	65	68	62	48	63

Jyndevad

The experimental area at Jyndevad is divided into seven fields and the crop rotation is spring barley, grass/clover, grass/clover, grass/clover, spring oat, winter rye and potatoes. Each of these fields is subdivided into five manure treatments. The yields in 2001 are shown in Table 3 for each of the manure treatments.

The crop rotation will be changed from 2003 to a cereal, pulse and potato based system without grass-clover crops, but with extensive use of legume based cover crops.

Table 3. Yields (hkg/ha) in the manure treatments at Jyndevad in 2001. The spring barley was taken as whole crop for silage, and yields here are dry matter.

Manure treatment	Potatoes	Oats	Winter rye	Spring barley
No manure	131	46	20	36
0.8 LU/ha in slurry	258	49	24	77
1.4 LU/ha in slurry	326	51	30	92
0.8 LU/ha in deep litter	233	55	16	50
1.4 LU/ha in deep litter	258	50	26	60

Foulum

Only one experimental area is maintained at Foulum with EXUNIT, a dairy farm rotation. This dairy farm rotation has been managed organically since 1987. Yields are recorded in a reference area. An analysis of yields, nutrient balances and soil contents of K and P for the period 1987 to 1998 have shown that the soil contents of P and K are stable. The P and K applied in manure are almost in balance with the nutrients removed by the crops. The yield level was consistently high with cereal yields of about 5 t DM/ha, whole crop cereal yield and yield of first grass cuts of about 8 t DM/ha and fodder beet yields of about 15 t DM/ha.

The funding of this rotation as a separate unit ends by 2002. However, it will be continued in the experiment "Nutrient cycling in dairy farming" described under section C.1.2 below.

Flakkebjerg

The organic research area at Research Centre Flakkebjerg has been intensively used for experiments from DARCOF-, EU- and other projects concerned with plant production and protection in organic farming. For the past couple of years there have been no experiments in the sugar beet field, whereas there is usually a greater demand than supply of fields for other crops, mainly cereals. The yields in the cereal fields have been followed over the years. The yield in spring barley has been stable around 4-4.5 tons/ha except for two years with a lower yield. In oat, the yield has been stable around 6 tons/ha except for two years with a late harvest. In winter wheat, the yield has been less stable, between 4.5 and 7 tons/ha. In pulses (lupin or a pea/barley mixture) the yield has been low every year, around 3 tons/ha. The number and biomass of annual weeds does not seem to be increasing over the years, but the number and biomass of perennial weeds, especially Canadian thistle (Cirsium arvense) has been increasing.

The crop rotation will be changed from 2003 introducing more cereals in the rotation and reducing the use of lucerne in the rotation.

KVL Taastrup

There are two experimental areas at KVL-Taastrup, the CFE-system and the organic crop rotation. The idea of the CFE-system is to grow short rotation coppice in strips between food crops to get an energy crop in addition to the food crops. Belts consisting of Alnus glutinosa (red alder), Salix spp. (willows) and Corylus avellana (hazel) are harvested every fourth year, next time in 2004. The average grain yields of 4.2 t/ha was obtained in spring barley and 5.5 t/ha in spring oats. The DM yields of grass-clover was 10.7 t/ha and 13.5 t/ha was obtained in fodder beet roots.

The organic crop rotation is a five-course rotation with two years of grass-clover. Here grain yields of about 3.5 t/ha has been obtained in spring barley, 6.3 t/ha in winter wheat, 12 t DM/ha in fodder beet roots.

Both rotations will be changed from next year. The CFE-system will be changed to a system with two years of grass-clover, whereas the organic crop rotation will be changed to a system with cereals and pulses, and one year of red clover for seed production. The CFE-system will thus more resemble a rotation for a cattle farm, whereas the organic rotation will be representative of an arable organic farm.

Årslev, vegetables

The yields of the crop rotation seem to have stabilised. The yields of carrot and leek are very high and similar to the yield of these crops in conventional production. The yields of the other crops, onion, white cabbage, green peas, and the two barley crops are roughly 25% lower than the yield of similar conventional crops. Limited N supply is only part of the reason for the yield reduction. Weeds and pests seem to be the main reason for the yield reduction in onion and peas, whereas N limitation is an important part of the explanation for reduced yields of cabbage and barley.

There has been no consistent trend in the yields of the rotation. The yield of barley and peas are now somewhat lower than in the first years, whereas the yields of the other vegetable crops have been increasing slightly. No declining trend has been observed in the concentration of N, P and K in the plant material or in the N_{min} measurements made in May and November. The most productive crops, carrot and white cabbage have both shown an N uptake of approx. 200 kg N ha^{-1}. On average more than 100 kg N ha^{-1} have been harvested (average of all six years including the full year green manure where no N was harvested) and 80 kg N ha^{-1} have been removed from the crop rotation per

year. In conclusion the results show that the system can be stable during a long period without any import of plant nutrients.

The results have consistently shown very good effects of green manure crops, which are only allowed to grow in the autumn after harvest of a barley crop. The difference between full year green manure and such autumn green manure crops appear to be surprisingly small, only in the order of 20-50 kg N ha^{-1} in first year effect. This points to autumn green manure as a very attractive method.

The results also show that the strategies of growing deep rooted species where N may have leached to deeper soil layers are working and of maintaining autumn soil cover as frequently as possible have worked as intended. The crop cover has been achieved in very different ways from grass/legume mixtures growing in the autumn, to fodder radish catch crops and the stubble of cabbage, which have been allowed to continue its growth after harvest. Irrespecitive of these different approaches, the results have shown that autumn crop cover have strongly improved the timing of N availability in the soil. Where the soil has been covered by a crop in the late autumn, much less N_{min} was found in the soil in November, but more in May than in the fields where autumn crop cover could not be obtained.

The crop rotation will be changed by omitting the grass-clover crop in the rotation.

Årslev, fruit and berries

The trials planted in the research area are shown in Table 4. Only the black currant trials are financed by EXUNIT. The other trials have mostly alternative funding. The apple research is funded by project: Development of sustainable production systems for apples (FØJOII-DJF-2).

Table 4. Trials carried out in the fruit and berries research area at Årslev.

Crop	Year	Experiment
Black currants	1997	Susceptibility of sulphur for 3 black currant varieties
	1996	Cover crops as fertiliser in 5 varieties
	1996	Black currants on legs
Strawberries	1999	Unsprayed varieties
Mini-kiwi	1996	Unsprayed varieties
Rose hips	2000	Unsprayed clones
	2000	Soil treatment, including irrigation and fertilisation
Apples	1994	Cover crops in apple scab resistant varieties
	2002	Early testing of new resistant selections
	2001	Reducing apple scab infection risk using cultural methods

To control powdery mildew in black currants sulphur is sprayed every 2 weeks from April to before harvest. Even in the mildew susceptible variety Ben Lomond the sulphur had no effect on powdery mildew in 1999-2001. The leaf drop in July and September was reduced in 1999-2001, whereas the discolouring of the leaves increased with the sulphur concentration in all years. The yield was not affected by the sulphur treatment.

The best yielding varieties of black currants were‘Titania’, ‘Ben Alder’, and ‘Intercontinantal’. Whereas ‘Farleigh’ had a very low yield in 2001, due to late winter frost. ‘Ben Lomond’ is very susceptible to powdery mildew. ‘Farleigh’ was susceptible to rust and ‘Titania’ was rather resistant. There was an attack of leaf spot all years whereas rust was less precent. The annual cover crop had tendency towards a higher yield especially for ‘Titania’ and ‘Ben Alder’ in 2000 and 2001.

The funding of the trials on fruit and berries ends by end of 2002.

C.1.2 Field experiments as workshop units

The experimental area at Askov represents parts of the long-term fertilisation trial at Askov, which have now been converted to organic farming. The experimental treatments include different rates and types of application of animal manure. The measurements include yields and nutrient balances. Soil samples are taken every four years.

Three other experiments all function as both individual experiments and as experimental areas for other projects. The measurements include yields, nutrient balances and measurements of nitrate leaching by use of suction cups.

The Askov long term fertilisation experiment

In 1996 one of the four blocks (B4-field) of the Lermarken site of the Askov long-term experiments on animal manure and mineral fertilizers (established 1894) was converted to an organic farming workshop unit. This block includes treatments with cattle slurry (three levels), solid manure + liquid manure (four levels), and unmanured plots. The experiments grow a four-course rotation of spring barley, grass/clover, winter wheat and beetroot. For each fertilisation level, similar quantities of N, P and K are given in either cattle slurry (GY) or in solid + liquid cattle manure (FG).

The experiment has been carried through according to plans. Every year, dry matter yields and main nutrient contents for harvested crop parts have been obtained and stored separately in the database associated with the Askov long-term experiments.

It is concluded that the B4-field workshop unit has fulfilled its mission. The B4 field will continue with the present plan following termination of funding from DARCOF. However, the use of pesticides may be reintroduced in order to reduce the input of manpower.

Residual effects of pastures

Precrop effects and nitrate leaching caused by grassland has been investigated in the organic grass/clover experiment since 1997. Main conclusions are:

- The huge N-pool in grazed grassland mineralised upon cultivation presents a potential environmental hazard. This work showed that when using good management practices (spring ploughing and catch crops) the release of N from three-year-old grasslands gave a considerable residual effect for two years after ploughing with nitrate concentrations in leachates not exceeding the EU Drinking Water Directive upper limit of 50 mg l^{-1}. In the first year the residual effect of grazed grasslands was large enough for supplementary fertilizer to be unnecessary, but in the following years gradually more and more fertilizer N was required to obtain optimal yields. The total leaching loss from a dairy rotation depends on the utilization of the N accumulated in grassland. Leaching losses are minimized by including residual effects in the fertiliser budgets for crops following the ploughing of grasslands.
- The history of the grazed grassland (grass-clover or ryegrass, low or high N levels in feed) did not affect residual effects and nitrate leaching. Presumably, huge differences in N-input during the grassland phase of the crop rotation were equalised by substantial but variable N losses during grazing. Possibilities for further improving the utilisation of grassland N following cultivation are limited when the current knowledge has been implemented. If the N use efficiency of dairy farming systems is to be further improved the utilisation of N in the pasture phase must be considered regarding the frequency of pastures in the rotations and the management during grazing.

- In the winter 2000-2001 leaching from cultivated land, 1st and 7th year pasture was compared in associated plots, and in the winter 2001-2002 it was possible to compare 1st, 2nd and 8th year pasture allowing for estimates of the effect of increasing N accumulation in grassland on nitrate leaching. Both winters leaching losses from grass-clover were low and similar for all sward types ranging from 4 to 21 kg NO_3-N ha^{-1} yr^{-1}. Leaching losses from grazed ryegrass increased dramatically with increasing sward age. Apparently, the build-up of soil N reached equilibrium after 7-8 years of grazing resulting in a larger part of the fertiliser input being lost.

The experiment will be continued as planned.

Nutrient management in dairy farming

After the start of the experiment in 1994 the crop rotation and the manure treatments was slightly changed in 1998 and there are now plans for further adjustments in 2003 (Table 5). The adjustment gives the experiment a more principle character but at the same time the introduction of maize instead of fodder beets makes the experiment more like a current crop rotation.

Table 5. Changes planned for 2003.

Field	Crop rotation 2003-	Manure application2003- (kg ha^{-1})
1	Spring barley, undersown	1. Slurry 60N
2	1st grass-clover	2. Slurry 120 N
3	2nd grass-clover	3. **No manure**[3]
4	**Spring barley**[1] + catch crop	4. Deep litter 120 N
5	Oat + catch crop	
6	**Maize**[2] **+ catch crop**	

Before: [1]barley/pea whole crop, [2]Fodder beets without catch crop and [3]60N in deep litter.

Examples of the differences in yield between treatments and years are shown in Figure 1. All crops were significantly affected by the year and there were treatment differences as it appears in the barley crop. The N leaching losses were significantly affected by crops (Figure 2). The introduction of catch crops in 1998 caused a large decrease in the N-leaching the two first years after ploughing-in of the grass-clover.

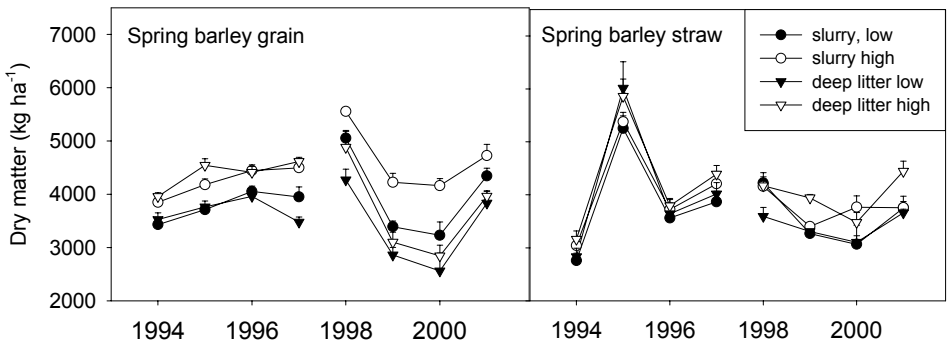

Figure 1. Dry matter yields of spring barley 1994-2001 as affected by treatments.

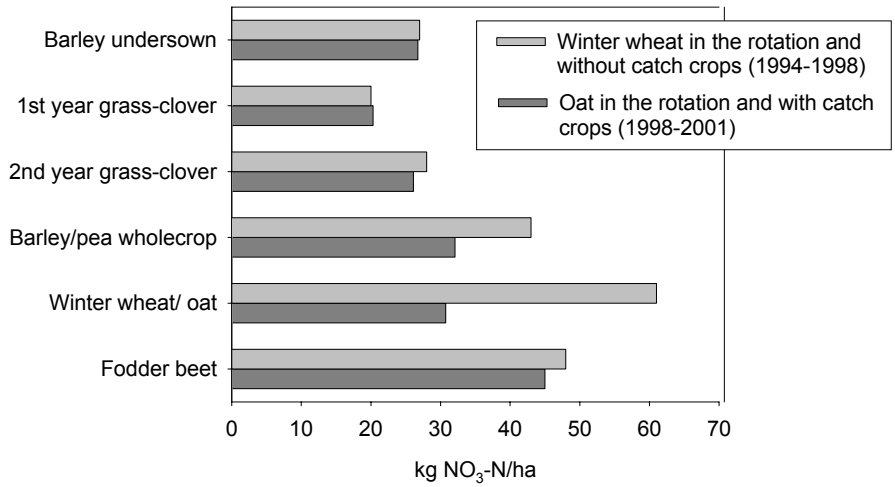

Figure 2. Leaching of nitrate-N as average of treatments and years for the two periods 94-98 and 98-01.

Crop rotation experiment

The field experiment on different aspects of crop rotations for cereal production in organic farming was started in 1997. Three factors are included in the experiment in a factorial design with two replicates: A) fraction of grass-clover and pulses in the rotation (crop rotation), B) catch crop (without or with catch crop or bi-cropped clover), and C) fertiliser (without or with animal manure applied as slurry). The crop rotations during the first four years of the experiment are shown in Table 6, and the revised crop rotations for 2001-2004 is shown in Table 7. All fields in all rotations are represented each year. The experiment is conducted at four locations, representing different soil types and climate regions in Denmark.

Table 6. Crop rotations with and without catch crops in the crop rotation experiment (CRE) in 1997-2000. The sign ':' indicates that a grass-clover ley, or a clover, ryegrass or ryegrass/clover catch crop is established in a cover crop of cereals or pulses. The sign '/' indicates a mixture of peas and spring barley or bi-cropping of winter cereals and clover.

Catch crop	Rotation 1	Rotation 2	Rotation 3	Rotation 4
Without	S. barley:ley	S. barley:ley	S. barley:ley	Spring oat
	Grass-clover	Grass-clover	Grass-clover	Winter wheat
	Spring wheat	Winter wheat	Winter wheat	Winter cereal
	Lupin	Peas/barley	Beet	Peas/barley
With	S. barley:ley	S. barley:ley	S. barley:ley	S. oat:clover
	Grass-clover	Grass-clover	Grass-clover	W. wheat/clover
	S. wheat:Grass	W. wheat:Grass	W. wheat:Grass	W. cereal/clover
	Lupin:Grass	Peas/barley:Grass	Beet	Peas/barley:Grass

Table 7. Crop rotations with and without catch crops in the crop rotation experiment (CRE) in 2001-2004. The sign ':' indicates that a grass-clover ley, or a clover, ryegrass or ryegrass/clover catch crop is established in a cover crop of cereals or pulses. The sign '/' indicates a mixture of peas and spring barley.

Catch crop	Rotation 1	Rotation 2	Rotation 3	Rotation 4
Without	S. barley:ley	S. barley:ley	S. barley:udlæg	Winter wheat
	Grass-clover	Grass-clover	Grass-clover	S. oat
	S. oat	Winter cereal	Winter wheat	S. barley
	Pea/barley	Lupin	Beet	Lupin
With	S. barley:ley	S. barley:ley	S. barley:ley	W. wheat:clover
	Grass-clover	Grass-clover	Grass-clover	S. oat/clover
	S. oat:gr+ci	W. cereal:gr+ci	W. wheat:gr+ci+cl	S. barley:gr+ci
	Pea/barley:gr+ci+cl	Lupin:gr+ci+cl	Beet	Lupin

gr+ci: grass+chicory
gr+ci+cl: grass+chicory+clover

The average for the entire rotation is calculated as the total yield of the four experimental years divided by four. This accounts for the fact that the grass-clover field in rotations 1 and 2 does not contribute to the yield. Table 8 shows that manure application increased yields in all cases. The higher effect of manure in rotation 4 compared with the other rotations results from use of higher manure rates in rotation 4. This is caused by higher recommended rates for the winter cereals in rotation 4.

Use of catch crops only affected rotation yields slightly. In rotation 2 there were positive yield effects of catch crops in spring barley only, which gave yield increases for the rotation of ca. 0.1 t/ha. Catch crops in rotation 4 gave yield increases of 0.3 t/ha at Flakkebjerg, but a yield decrease of 0.5 t/ha at Foulum. This difference is mainly caused by the bicropping of wheat and clover that resulted in yield reductions at Foulum, but small yield benefits at Flakkebjerg. The oat crop was much more vigorous at Foulum compared with Flakkebjerg, and this resulted in a weaker stand of white clover and thus less nitrogen available for the winter wheat in the bicropping system.

There were only very small yield differences between rotations 1 and 2 at Jyndevad. Growing winter cereals at this site does thus not increase yields in organic farming systems. The yield at rotation level was higher in rotation 4 compared with rotation 2. The difference was about 0.4 t/ha without manure, and about 0.8 t/ha with manure. The yield benefits from the grass-clover crop could thus not outweigh the yield reductions caused from leaving a quarter of the rotation out of production.

Table 8. Average annual grain yields for the entire rotation for 1997 to 2000 (t/ha with 15% water).

Location	Year	Rotation 2		Rotation 4	
		Without	With	Without	With
Jyndevad	1	2.0	2.7	2.2	2.7
(sand)	2	2.2	2.6	2.2	3.0
Foulum	2	3.1	3.8	3.2	3.9
(loamy sand)	4	3.6	5.0	3.6	4.5
Flakkebjerg	2	2.5	3.1	2.7	3.1
(sandy loam)	4	2.8	3.9	3.1	4.2

The yield of spring barley in rotation 2 was affected by the catch crop of the preceding pea/barley crop (Table 9). The average yield increase for catch crop was 0.8 t/ha at Jyndevad, 0.6 t/ha at Foulum and 0.3 t/ha at Flakkebjerg. The largest yield increases were thus obtained at the sandy soil, which may be related to the higher risk of nitrate leaching on the sandy soil. Leaching of potassium on the sandy soil may also play a role.

There are large differences between years. In 1999 large yield increases were obtained from catch crops at all sites. The average yield increase for catch crop across all sites was thus 1.1 t/ha in 1999, but only 0.2 and 0.3 t/ha in 1998 and 2000, respectively. The climatic conditions in the individual year probably plays a considerable role for the release of nitrogen from the catch crop and for uptake by the crop.

Table 9. Grain yield in spring barley in rotation 2 (t/ha with 15% water).

Location	Year	Without catch crop		With catch crop	
		÷ manure	+ manure	÷ manure	+ manure
Jyndevad	1998	1.4	1.7	1.7	2.3
(sand)	1999	1.3	2.4	2.2	4.0
	2000	2.1	3.8	3.0	4.1
	2001	2.3	3.6	2.6	4.8
Foulum	1998	4.7	5.6	4.5	6.3
(loamy sand)	1999	1.9	3.7	3.6	4.3
	2000	3.1	4.4	3.0	5.1
	2001	4.3	5.9	4.8	5.9
Flakkebjerg	1998	2.9	3.3	2.6	3.4
(sandy loam)	1999	1.5	3.3	2.5	4.3
	2000	2.8	4.1	2.9	3.9
	2001	2.9	4.1	3.7	4.7

Leaching of nitrate was highest on the coarse sandy soil at Jyndvad. As a average of the first rotation, a total of 11, 26, 33 and 92 kg N/ha were leached from rotation 2 without catch crops and with manure at Holeby, Flakkebjerg, Foulum and Jyndevad, respectively. The leaching may actually be even smaller at Holeby and Flakkebjerg, since the rooting depth may exceed the depth of the installed ceramic suction cells. The suction cells to sample soil water are installed at 0.8 m at Jyndevad and at 1 m depth at the other sites.

Incorporation of grass-clover in the autumn prior to sowing of winter wheat doubled the leaching compared with leaching from spring barley with undersown grass-clover (Fig. 3). This higher level was sustained in the following crops. A leaching season is defined from 1 April to 31 March in the following year. The grass-clover is thus attributed a large leaching loss after incorporation in the autumn.

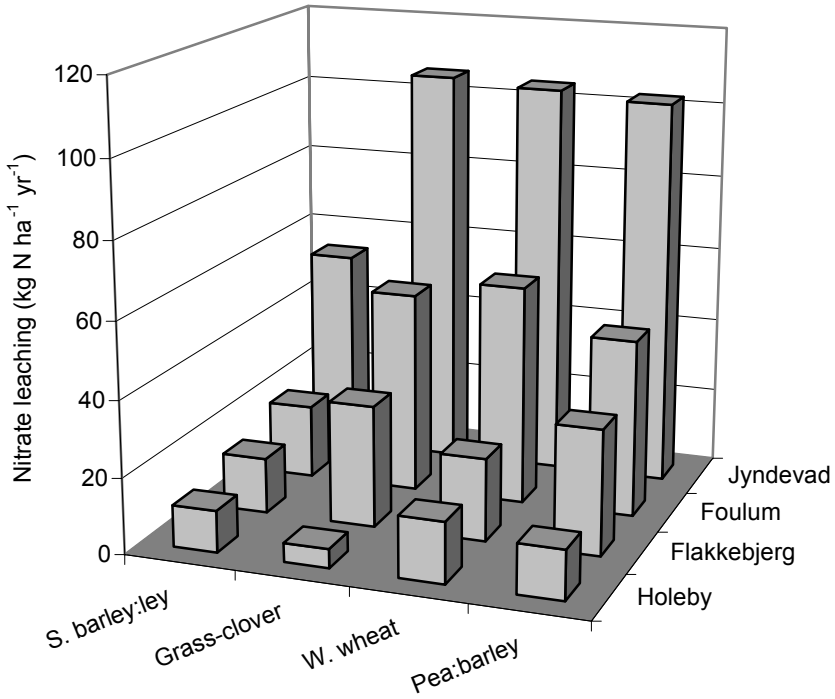

Figure 3. Annual nitrate leaching in rotation 2 with manure and without catch crops.

The use of catch crops reduced the N leaching by 33% af Jyndevad in both rotations 1 and 2 (Table 10). At Foulum catch crops reduced the leaching by ca. 25% in rotation 2, whereas there was no effect in rotation 4.

White clover was a major component of the catch crop in rotation 4, and this may have caused the lacking effect on leaching. On the sandy loam at Flakkebjerg, there was not significant effect of catch crops on leaching. However, the level of N leaching was already very low here

Table 10. Nitrate leaching from the rotations with and without catch crops, 1997-2000 (kg N/ha).

Location	Rotation	Without catch crop	With catch crop
Jyndevad	1	102	68
	2	95	64
Foulum	2	50	38
	4	34	37
Flakkebjerg	2	32	27
	4	25	25

At Jyndevad weeds are most pronounced in spring wheat and winter wheat, which are less competitive. At Foulum all crops with undersown grass-clover or catch crop have high weed biomass. Mechanical weed control was not applied at Foulum in cereals or pulses with undersown crops. There were also large weed densities in the winter cereals in the bicropping system in rotation 4. It is difficult to control weeds in the cereal-clover bicropping system.

At Jyndevad there were a clear tendency for declining weed biomass, whereas the weed biomass tended to increase at the other sites. The reason may be an initially high weed density at Jyndevad, and a large effort to control weeds at this site, including later sowings of under-

sown crops to allow mechanical weed control in these crops. At the other sites only crops without catch crops were subjected to mechanical weed control, which may have lead to weed propagation.

C.1.2 Demonstration and communication

Field days have been held at all experimental units, and additionally a number of farmers groups and other guests have visited the workshop units

In June 2002 a course was organised by the Danish advisory service. The course was held at the experimental station Jyndevad with 20 participants mainly agricultural advisors. At the course project leaders and co-workers presented 8 projects and associated results. The presentation was run with oral presentation of relevant papers and demonstration and monitoring the respective field trials hosted by Jyndevad experimental station. A CD-rom containing photos from the course including demonstration and visiting the field trials was produced and distributed to the participants.

The Danish Agricultural Advisory Centre has conducted a survey on organic farmers' preferences for farming topics and relevant media. The results from the survey will be taken into account when designing a homepage presenting the results and activities from EXUNIT and EXUNIT-2 at the end of 2002. The survey suggests farmers' discussion groups, newsletters of organic farming and field days as the preferable media for presenting new knowledge and results from organic research. The survey also suggests that the most important topic of interest to organic farmers is how to deal with perennial weeds in organic farming in the future.

An external advisory board has been established with representation of organic farmers, agricultural advisors and teachers. The board met in 2002 to discuss the proposed changes in crop rotations on the experimental units.

C.2 Fulfilment of deliverables and milestones

EXUNIT WP1. Project coordination	Time schedule according to application	Deviations, if any*
Task		
1. Coordination of project plans and reporting	2000-2004	
2. Planning of field days	2000-2004	
3. Ensure high experimental standards	2000-2004	
Deliverables		
1. Annual reports	200x/10	delivered
2. Report on future status of experimental units	2002/12	delivered
3. Final report	2005/03	
4. Field days for farmers and advisors	200x/06	
Milestones		
1. End of external funding for most units	2002/12	
2. End of external funding for the CRE unit	2003/12	
3. End of external funding for the RUG unit	2004/12	

** Deviations are to be further discussed at C3*

EXUNIT WP2. Workshop areas at experimental stations	Time schedule according to application	Deviations, if any*
Task		
1. Provide workshop facilities	2000-2002	
Deliverables		
1. Annual reports	200x/10	delivered
4. Field days for farmers and advisors	200x/06	delivered
5. Fact sheets on results from workshop areas	2002/12	
Milestones		
1. End of external funding	2002/12	

** Deviations are to be further discussed at C3*

EXUNIT WP3. Long-term fertilisation experiment	Time schedule according to application	Deviations, if any*
Task		
1. Provide workshop facilities	2000-2002	
Deliverables		
1. Annual reports	200x/10	delivered
4. Field days for farmers and advisors	200x/06	delivered
Milestones		
1. End of external funding	2002/12	

** Deviations are to be further discussed at C3*

EXUNIT WP4. Workshop areas on residual effect of pastures	Time schedule according to application	Deviations, if any*
Task		
1. Precrop effect of pastures	2000-2002	
Deliverables		
1. Annual reports	200x/10	delivered
4. Field days for farmers and advisors	200x/06	delivered
Milestones		
1. End of ley phase	2002/03	
2. End of external funding	2002/12	

** Deviations are to be further discussed at C3*

EXUNIT WP5. Nutrient management in dairy farming	Time schedule according to application	Deviations, if any*
Task		
1. Effect of livestock density and manure type	2000-2002	
Deliverables		
1. Annual reports	200x/10	delivered
4. Field days for farmers and advisors	200x/06	delivered
6. Paper on nitrate leaching and crop production	2002/12	
7. Farmers journal article	2002/12	
Milestones		
1. End of field experiment	2002/03	fulfilled

WP6. Crop rotation experiment	Time schedule according to application	Deviations, if any*
Task		
1. Crop rotation effect on production etc.	2000-2004	
2. Provide workshop facilities	2000-2003	
Deliverables		
1. Annual reports	200x/10	delivered
4. Field days for farmers and advisors	200x/06	delivered
8. Reviewed journal papers from first rotation course	2002/02	(delivered)*
9. Fact sheets from first rotation course	2002/04	delivered
10. Article on previous years results	200x/03	delivered
11. Articles on crop status during the seasons	200x	delivered
Milestones		
1. Revised project guidelines	200x/03	fulfilled
2. First course of crop rotation is completed	200x/03	fulfilled
3. End of external funding for experiment	2004/03	

** Deviations are to be further discussed at C3*

WP7. Organic experimental station, Rugballegaard	Time schedule according to application	Deviations, if any*
Task		
1. Provide workshop facilities	2000-2004	
2. Make whole-farm assessments	2000-2004	
3. Demonstration and communication	2000-2004	
Deliverables		
1. Annual reports	200x/10	delivered
4. Field days for farmers and advisors	200x/06	delivered
Milestones		
1. End of external funding	2004/12	

** Deviations are to be further discussed at C3*

EXUNIT-2 WP1. Dedicated workshop areas	Time schedule according to application	Deviations, if any*
Task		
1. Provide workshop facilities	2003-2004	
Deliverables		
1. Annual reports	200x/10	delivered
2. Final report	2005/03	
4. Field days for farmers and advisors	200x/06	delivered
7. Articles in farmers journals	200x	
Milestones		
1. Decision on revised crop rotations	2002/03	delivered
2. Implementation of revised crop rotations	2003/04	

** Deviations are to be further discussed at C3*

EXUNIT-2 WP2. Experiments as workshop areas	Time schedule according to application	Deviations, if any*
Task		
1. Crop rotation experiment	2004-2005	
2. Nutrient management in organic dairy farming	2002-2004	
3. Residual effects of grazed pastures	2003-2004	
Deliverables		
1. Annual reports	200x/10	delivered
2. Final report	2005/03	
4. Field days for farmers and advisors	200x/06	delivered
7. Articles in farmers journals	200x	
Milestones		
1. Implementation of revised crop rotation in task 2	2003/04	
2. Second rotation of crop rotation exp. completed	2005/03	

** Deviations are to be further discussed at C3*

EXUNIT-2 WP3. Demonstration and communication	Time schedule according to application	Deviations, if any*
Task		
1. Contact group for the workshop areas	2002-2004	
2. Field days and courses	2002-2004	
3. Information on the web	2002-2004	
Deliverables		
1. Annual reports	200x/10	delivered
2. Final report	2005/03	delivered
3. Meetings in the contact group	200x/02	delivered
4. Field days for farmers and advisors	200x/06	delivered
5. Seminars for agricultural advisors	200x/06	delivered
6. Information on the web	200x/10	
Milestones		
1. Web site implemented	2002/10	

** Deviations are to be further discussed at C3*

D. Description of deviations and subsequent adjustments of plans

The publication of the results from the first course of the crop rotation experiment has been delayed due to other obligations by the project leaders of the experiment. However, the remaining papers will be submitted in 2003.

E. Project publications and other products

1. Articles in international, scientific journals with peer review

Askegaard, M. & Eriksen, J. (2000). Potassium retention and leaching in an organic crop rotation on loamy sand as affected by contrasting potassium budgets. *Soil Use and Management* **16**, 200-205.*

Askegaard M. & Eriksen J. (2002). Exchangeable potassium in soil as indicator of potassium status in an organic crop rotation on loamy sand. *Soil Use and Management* **18**, 84-90. *

Askegaard, M., Eriksen, J. & Olesen, J.E. (in press). Exchangeable potassium and potassium balances in organic crop rotations on a coarse sandy soil. *Soil Use and Management.* *

Christensen, B.T. & Johnston, A.E. (1997). Soil organic matter and soil quality: Lessons learned from long-term field experiments at Askov and Rothamsted. In E.G. Gregorich & M.R. Carter (Eds.): Soil Quality for Crop Production and Ecosystem Health. Elsevier Science Publ., Amsterdam, 399-430. **

Eriksen, J. & Jensen, L.S. (2001). Soil respiration and nitrogen mineralisation in situ following cultivation of temporary pastures. *Biology and Fertility of Soils* **33**, 139-145. **

Eriksen, J. (2001). Nitrate leaching and growth of cereal crops following cultivation of contrasting temporary grasslands. *Journal of Agricultural Science, Cambridge* **136**, 271-281. **

Eriksen, J., Olesen, J.E. & Askegaard, M. (2002). Sulphur leaching and sulphur balances of an organic cereal crop rotation on three Danish soils. *European Journal of Agronomy* **17**, 1-9. **

Eriksen J. & Thorup-Kristensen K. (2002) The effect of catch crops on sulphate leaching and availibility of S in the succeeding crop on sandy loam soil in Denmark. *Agriculture, Ecosystems and Environment* **90**, 247-254. **

Guggenberger, G., Christensen, B.T. & Rubæk, G.H. (2000). Isolation and characterization of labile organic phosphorus pools in soils from the Askov long-term field experiments. *Journal of Plant Nutrition and Soil Science* **163**, 151-155. **

Iversen, C.K., Pedersen, H.L., Olsen, C.E. & Brandt, K. (in press). Relationship between phenolic compounds, disease resistance and cover crop type of 5 black currant (*Ribes nigrum L.*) varieties. *Journal of Biological Agriculture & Horticulture*. *

Kühn, B.F. & Thybo, A.K. (2001). Sensory quality of scab-resistant apple cultivars. *Postharvest Biol. Technol.* **23**, 41-50. **

Munkholm, L.J., Schjønning, P., Debosz, K., Jensen, H.E. & Christensen, B.T. (2002). Aggregate strength and mechanical behaviour of a sandy loam soil under long-term fertilization treatments. *European Journal of Soil Science* **53**, 129-137. **

Olesen, J.E., Askegaard, M. & Rasmussen, I.A. (2000). Design of an organic farming crop rotation experiment. *Acta Agriculturae Scandinavica, Section B, Soil and Plant Science* **50**, 13-21.

Olesen, J.E., Rasmussen, I.A., Askegaard, M. & Kristensen, K. (in press). Whole-rotation dry matter and nitrogen grain yields from the first course of an organic farming crop rotation experiment. *Journal of Agricultural Science, Cambridge*.

2. Presentations at congresses, symposiums etc

Askegaard, M., Olesen, J.E. & Rasmussen, I.K. (submitted). Lokalitetens og dyrkningsvilkårenes betydning i økologisk planteavl. I Corell, A., Kjær, L.B. & Frederiksen, H.B. (eds.): Efterårskonferencen 2002 - Planteavl. DJF rapport Markbrug 78, 67-70.

Brandt K., Larsen HN., Andersen JO., Mølgaard J. P., Lauridsen C., Jørgensen H., Gundersen V., Larsen E., Badsberg JH., Lindhard Pedersen H. and Thorup-Kristensen K. (2001). Organic food and health. A new project to study the effects of plant cultivation methods on nutritional value and on health and reproduction in an animal experiment. Poster. **

Callesen, O., Pedersen, H.L. & Daugaard, H. (2000). Research and development needs for organic fruit production. Workshop on Organic Fruit opportunities and challenges. 16-17 October 2000, England. **

Christensen, B.T. (2000). Hvad forstås ved begrebet jordfrugtbarhed. *Tidsskrift for Landøkonomi* **187**, 276-279. **

Daugaard, H., K. Thorup-Kristensen, L. Petersen, B. Leonhard, H. Lindhard, M. Korsgaard, B. Rasmussen, J. Solvang, O. B. Hansen og J. Jensen 2001. Vurdering af økologisk produktion i gartneri og frugtavl. Rapport til Kirsten Jensen Udvalget. 103 pp. **

Eriksen, J. & Søegaard, K. (2000). Nitrate leaching following cultivation of contrasting temporary grassland. *Grassland Science in Europe* **5**, 577-579. **

Eriksen J. & Søegaard K. (2000) Nitrate leaching following cultivation of contrasting temporary grasslands. Preceedings from Eurosoil 2000. University of Reading 4-6 September 2000. British Society of Soil Science. 2 pp. **

Eriksen J. & Vinther F.P. (2002) Nitrate leaching in grazed grasslands of different composition and age. *Grassland Science in Europe* **7**, 682-683. **

Iversen, C.K., Lindhard Pedersen, H. & Brandt, K., 2000. Phenolic compounds and disease resistence of 5 blackcurrant varieties in organic growing system. Presentation at 9th Internationaler Erfahrungsaustauch über Forschungsergebnisse zum ökologischen Obstbau in Weinsberg, 1-2. February 2000. **

Lindhard H. (2001). Vurdering af mulighederne for forebyggelse og alternativ bekæmpelse i frugt og bær. Rapport til Kirsten Jensen udvalget. **

Lindhard Pedersen H. (2002). Cover crops in Blackcurrants. 8th International Rubus and Ribes Symposium, 9-11 July 2001. Acta Horticulturae (in press).

Lindhard Pedersen, H. & Bertelsen, M. (2002). Alleyway groundcover management and scab resistand apple varieties. ECO-FRU-VIT. 10th International Conference on Cultivation technique and Phytopathological problems in Organic Fruit-Growing and Viticulture. p. 16-21. **

Melander, B., Rasmussen, K., Rasmussen, I.A. & Jørgensen, M.H. (2001): Radrensning med og uden ukrudtsharvning i vintersæd om foråret i samspil med forskellige dyrkningsfaktorer. 18. Danske Planteværnskonference, marts 2001. DJF Rapport nr. 40, markbrug, s. 211-226. **

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 the 17th World Congress of Soil Science. CD-rom, 830. **

Olesen, J.E., Askegaard, M. & Rasmussen, I.A. (2000). Udnyttelse af husdyrgødning i sædskifter til økologisk planteavl. FØJO-rapport 7, 75-82.

Olesen, J.E., Askegaard, M. & Rasmussen, I.A. (2000). Crop production during the first course of an organic crop rotation trial in Denmark. *Aspects of Applied Biology* **62**, 187-195.

Olesen, J.E., Askegaard, M. & Rasmussen, I.K. (submitted). Sædskiftets indre dynamik i økologisk planteavl. I Corell, A., Kjær, L.B. & Frederiksen, H.B. (eds.): Efterårskonferencen 2002 - Planteavl. DJF rapport Markbrug 78, 71-74.

Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2000). Crop rotations for grain production. In: T. Alföldi, W. Lockeretz & U. Niggli (Eds.) Proceedings 13th International IFOAM Scientific Conference, 28-31 August 2000, Basel. p. 145.

Pedersen, H.L., Korsgaard, M. & Daugaard, H. (2000). Organic fruit production in Denmark.

Growers Experiences in Denmark. Workshop on Organic Fruit opportunities and challenges. 16-17 October 2000, England.**

Rasmussen, I.A., Askegaard, M. & Olesen, J.E. (2000). Weed control in organic crop rotation experiments for grain production. In: T. Alföldi, W. Lockeretz & U. Niggli (Eds.) Proceedings 13th International IFOAM Scientific Conference, 28-31 August 2000, Basel. p. 182.

Rasmussen, I.A., Melander, B., Rasmussen, K., Jensen, R.K., Hansen, P.K., Rasmussen, G., Christensen, S. & J. Rasmussen (2000): Recent advances in weed management in cereals in Denmark. In: T. Alföldi, W. Lockeretz & U. Niggli (eds.): Proceedings 13th IFOAM Scientific Conference, 28-31 August 2000, Basel. P. 178. **

Thorup-Kristensen, K., (2002). Utilising differences in rooting depth to design vegetable crop rotations with high nitrogen use efficiency (NUE). Acta Hort. 571, 249-254. **

Thorup-Kristensen, K. (2002) Six years results from an organic vegetable crop rotation aimed at sufficiency in nitrogen. Book of abstracts, XXVIth International Horticultural Congress & Exhibition (IHC2002), Toronto, August 2002

3. Articles in agricultural journals etc.

Askegaard, M. (2000). Forår uden problemer. *Økologisk Jordbrug* **217**, 8.

Askegaard, M. (2000). Nyt fra sædskifteforsøg. *Økologisk Jordbrug* **223**, 8.

Askegaard, M. (2001). Nyt fra forsøg med økologiske sædskifter. *Økologisk Jordbrug* **241**, 6.

Askegaard, M. (2001). Nyt fra de økologiske sædskifteforsøg. *Økologisk Jordbrug* **247**, 6.

Askegaard, M., Olesen. J.E. & Rasmussen, I.A. (2002). Sædskiftet holder på kvælstoffet. *Økologisk Jordbrug* **264**, 8.

Brandt, K. & Christensen, B.T. (1999). Næringstilførslens betydning for indholdet af fenoliske sekundære metabolitter i økologisk dyrket hvede. Forskningsnytt om Økologisk Lantbruk i Norden nr. 6, oktober 1999, 10-11.

Eriksen, J. (2001). Ompløjning af græsmarker kan give stor udvaskning. *Økologisk Jordbrug* **242**, 6.

Eriksen, J. & Mogensen, J. (2001). Ompløjning af afgræsningsmarker. Forfrugstværdi og N-udvaskning. *Grøn Viden Markbrug* nr. 237.

Lindhard, H. 2001. Gødskning med kvælstof i solbær. Frugt og Bær, 4/2001. S. 94-95.**

Lindhard, H. 2001. Dækkultur i økologisk solbærdyrkning. Frugt og Bær. 6/2001.

Lindhard, H. 2002. Nye æbler på vej. Økologisk Jordbrug.nr. 270. S 6. **

Lindhard, H. & Callesen, O. (2001). La production fruitiere biologique en Europe. Le Fruit Belge, s. 111-114.

Melander, B. & Rasmussen, I.A. (2001): Radrensning tager besværligt ukrudt. Økologisk jordbrug 24. August, nr. 9. **

Olesen, J.E. (2000). International forskning i økologiske sædskifter. *Økologisk Jordbrug* **209**, 8.

Olesen, J.E. (2000). Status i sædskifteforsøget. *Økologisk Jordbrug* **225**, 8.

Olesen, J.E. (2000). Synlige forskelle i sædskifteforsøget. *Økologisk Jordbrug* **219**, 8.

Olesen, J.E. (2000). Europæisk forskning i sædskifter til økologisk jordbrug. *Forskningsnytt om økologisk jordbrug* nr 2, 16-17.

Olesen, J.E. (2001). Sommeren står for døren i sædskifteforsøget. *Økologisk Jordbrug* **243**, 8.

Olesen, J.E. (2001). Gunstige effekter af efterafgrøder i forsøg. *Økologisk Jordbrug* **245**, 8.

Olesen, J.E. (2002). Sommer i sædskifteforsøget. *Økologisk Jordbrug* **268**, 6.

Olesen, J.E., Rasmussen, I.K. & Askegaard, M. (2000). Danske forskere tester sædskifter. *Økologisk Jordbrug* **215**, 14.

Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2000). Økologisk vinterhvede kan lykkes på god jord. *Landsbladet Mark* nr. 8, 26.
Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2001). Udbytter i sædskifter til økologisk kornproduktion. *Forskningsnytt om økologisk landbruk i Norden* 2-2001, 12-13.
Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2001). Planteavl uden kløvergræs mulig. *Økologisk Jordbrug* **238**, 8.
Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2001). Fangafgrøder øger udbyttet. *Økologisk Jordbrug* **238**, 9.
Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2002). Forsøgssædskifter til økologisk kornavl. *Økologisk Jordbrug* **264**, 9.
Pedersen, H.L. (2000). Nye solbærsorter fra skotland. *Frugt og Bær* 115.
Rasmussen, I.A. (2000). Nyt fra sædskifteforsøg. *Økologisk Jordbrug* **215**, 8.
Rasmussen, I.A. (2000). Nyt fra sædskifteforsøg. *Økologisk Jordbrug* **221**, 8.
Rasmussen, I.A. (2001). Nyt fra sædskifteforsøg. *Økologisk Jordbrug* **239**, 6.
Rasmussen, I.A. (2001). Nyt fra forsøg med økologiske sædskifter. *Økologisk Jordbrug* **249**, 6.
Rasmussen, I.A. (2002): Nyt fra de økologiske sædskifteforsøg – kløvergræsset i Jyndevad har været et smertensbarn. Økologisk Jordbrug, 22 (264), 6.
Rasmussen, I.A. (2002): Nyt fra de økologiske sædskifteforsøg – effekten af økologisk sædskifte begynder at vise sig. Økologisk Jordbrug, 22 (271), 6.
Rasmussen, I.A., Askegaard, M. & Olesen, J.E. (2001). Nye og bedre sædskifter. *Økologisk Jordbrug* **238**, 9.
Rasmussen, I.A., Askegaard, M. & Olesen, J.E. (2002). Problemer med rodukrudt. *Økologisk Jordbrug* **264**, 8.
Thorup-Kristensen, K., (2002). Grøntsagssædskifte uden tilførsel af gødning. *Økologisk Jordbrug* **22(258)**, 6.
Thorup-Kristensen, K., (2002). Økologisk grønsagssædskifte uden kvælstofimport. Plantemøtet Østlandet 2002, 12.-14. februar Norge. *Grønn Forskning* **2**, 139-144.
Thorup-Kristensen, K., (2001). Hea köögiviljasaak Sige külvikorraga. (Oversat til estisk fra: Økologisk grønsagsproduktion uden kvælstofimport. - Forskningsnytt om økologisk landbruk i Norden 1999, nr. 7). *MahepSllumajanduse leht* **17**, 7-8.

4. Other presentations at meetings, field days etc.

Askegaard, M., Olesen, J.E. & Rasmussen, I.K. (submitted). Lokalitetens og dyrkningsvilkårenes betydning i økologisk planteavl. Efterårskonferencen 2002.
Djurhuus, J. & Olesen, J.E. (2000). Characterisation of four sites in Denmark for long-term experiments on crop rotations in organic farming. *DIAS report No. 33.*
Eriksen, J. (2001). Eftervirkning af kløvergræs. I "Bilag til Efterårskonference 2001" s 64. 2. oktober, Hotel Nyborg Strand.
Eriksen J. & Mogensen J. (2001) Forfrugtsværdi og N-udvaskning efter ompløjning af flerårige græsmarker med forskellige forhistorier. *DJF rapport* nr. 46 Markbrug. 40 pp.
Eriksen J. & Sørensen P. (2002). Eftervirkning af afgræsningsmarker og husdyrgødning. I "Kvælstofbalancer på landbrugsbedriften – status og perspektiv". Intern DJF rapport nr. 157: 25-30. **
Olesen, J.E., Askegaard, M. & Rasmussen, I.K. (submitted). Sædskiftets indre dynamik i økologisk planteavl. Efterårskonferencen 2002.

Field days have been held at all experimental units, and there have also been several interviews on radio concerning the activities. A three-day course for agricultural advisors was held in May 2002 at Jyndevad. In addition many of the experiments have their own web-site on the internet.

F. Scientific education

The experimental units have also been used by students, both B.Sc., M.Sc. and Ph.D. students. in addition presentations and discussions have been carried out with many visiting national and international scientists.

The WP3 Askov long-term fertilization experiment had supported two M.Sc. thesis at Aarhus University, Department of Plant Ecology (April and May 2001). Ingrid S. Bleeg: Phenolic acids and flavonoids in organically grown spring barley (*Hordeum vulgare* L.) at different nutrient availability, and Dorthe B.F. Andersen: Infection of pathogenic fungi and contents of N and soluble phenols in leaves of barley (*Hordeum vulgare* L.) grown in the field at different nutrient additions.

The CFE-system and the organic crop rotation at KVL-Taastrup are used as resource tools during the European Common Curriculum (SOCRATES) course in Ecological Agriculture and other courses at KVL concerning organic farming and different production systems.

In the CFE-system at KVL-Taastrup several ongoing PhD projects and other studies have been completed or are nearing completion with studies of the carbon and nitrogen cycling within the CFE system (Andreas de Neergaard), the CFE's economic and energy balances (Bernd Kuemmel) and the effect of the CFE system on the distribution and ecology of predatory and herbivorous insects and their prey (Vibeke Langer and Karsten Dromph). In several of these studies reports are nearing publication in the international press.

As a part of a Ph.D. study done by Chr. B. Henriksen, Organic Farming Section, KVL, an experiment entitled "Long term effect of different weed control and soil management methods in fodder beets" will be carried out in the organic crop rotation at KVL-Taastrup.

The following Ph.D. students have been directly involved with the experimental units:

Anders Borgen. Varieties of organically grown cereals and legumes (organic crop rotation at KVL-Taastrup).

Lars Kristensen. Environmentally friendly methods for control of seed born pathogens on cereals (organic crop rotation at KVL-Taastrup).

Torben Sole Madsen. New ploughing techniques in Organic Agriculture.(Department for agricultural engineering).

Martin Nørregaard Hansen. Technology for reduction of N-losses in solid manure (Department for agricultural engineering).

The following M.Sc. students have been directly involved with the experimental units:

Søren S. Simonsen (2000). Influence of catch crops on nitrogen balance and yield in an organic crop rotation (crop rotation experiment at Foulum).

Mette Thyme (2001): Nitrogen uptake in Cirsum arvense and spring barley - in relation to the occurrence of thistles in organic crops (organic crop rotation experiment at Flakkebjerg).

J. Ulnitz (2000). False seed bed in fodder beets (organic crop rotation at KVL-Taastrup).

G. National and international cooperation

The experimental units in EXUNIT will been intensively used by other DARCOF coordinated projects.

WP2. Workshop areas and Jyndevad, Foulum, Årslev, Flakkebjerg and KVL-Taastrup

The crop rotation at Jyndevad has primarily been for experiments on potatoes (Jens Peter Mølgaard) and an experiment on ridge cropping (Chr. B. Henriksen).

The dairy crop rotation at Foulum has primarily been used for the nutrient cycling experiment described in WP5.

DINOG (I.13) subproject 2.1 has investigated N2-fixation in grass-clover at Jyndevad and Foulum.

Several experiments were carried out in the vegetable crop rotation at Årslev. This included seven experiments from DARCOF project I.10, one experiment from DARCOF project I.3 and two projects from a grass-root project concerning varieties for organic farming. The capacity for experiment is thus almost exhausted. In addition a number of samplings and measurements has been carried out to support other DARCOF projects.

For the vegetable crop rotation at Årslev there will be cooperation with the Norwegian project "Optimal crop rotation for cropping stability in organic vegetable production" (Optimalt vekstskifte for sikker økologisk grønnsakproduksjon) where Kristian Thorup-Kristensen is participating as advisor. There will be cooperation with the EU funded project EU-ROTATE where data from the crop rotation and some of the experiments preformed within it will be used for developing and testing advisory models for N in vegetable crop rotations. This project will start in the beginning of 2003.

The organic fields at Flakkebjerg have again in 2001 been intensively used for experiments by the projects under DARCOF and other projects concerning organic farming.

WP3. Askov long-term fertilization experiment

A long range of DARCOF projects have used material from the experiments (I.3, I.4, II.3, IV.1, IV.4, VI.1, VII.10). The spring wheat grown in 2001 in the B4-field is an integral part of the NIMAB (I.4) project.

WP4. Workshop area on grazing intensity and residual effects of pastures

NIMAB (I.4) subproject 1 has investigated the utilization of N in grazed grass-clover fields and subproject 4 has analysed wheat samples for quality aspects.
DINOG (I.13) subproject 2.1 has investigated N2-fixation in grass-clover and subproject 2.3 has looked at spatial variations and quantification of N_2O emission at field scale.
The EU-project "Greenhouse Gas Mitigation for Organic and Conventional Dairy Production" (MIDAIR) has used the experimental unit for N_2O studies.

WP6. Crop rotation experiment

The following additional activities have been carried out in the crop rotation experiment in 2001:

- Experiments with application of potassium in selected plots at Jyndevad (Margrethe Askegaard).
- Development in plant available soil potassium over time using soil samples from plots at Jyndevad (Margrethe Askegaard).
- Samplings and measurements in cereal crops at Foulum to determine C and N turnover (Jørgen E. Olesen, part of the BIOMOD project).
- Subsoil loosening in plots at Foulum and Flakkebjerg (Per Schjønning, part of the ROMAPAC project).
- Topsoil compaction in plots at Foulum and Flakkebjerg (Per Schjønning, part of the ROMAPAC project).

WP7. The organic experimental farm, Rugballegaard

The following projects are carried out in the fields at Rugballegaard

1. In the rotation system of the mixed farm system a research program **"Soil Fertility"** was carried out. The year 2000 was the last year of a 5 year period, where the basic issue of research was the comparison of Non inverting tillage systems with the traditional ploughing. The project is financed by DARCOF. Per Schjønning is the project responsible scientist.
2. The company Eco-Dan has in cooperation with DIAS developed a laser steered computer vision system that can steer hoeing equipment attached behind a tractor by following the rows. The organic experimental station collaborated with the developed on testing the eco-dan machine in a sugar beet crop.
3. Together with the Danish advisory system the experimental station was part of the Eco-demo project. This project demonstates new cultivation techniques for farmers. This year the demonstration plot was in the lupine crop, where two different species were sown, and different weed-strategies were tried out. Michael Tersbøl, Danish Agricultural Advisory Center, is responsible for this project.
4. From 1997-1999 a DARCOF financed project was carried out to investigate the possibility to practice mixed grazing with pregnant sows and heifers. The project was terminated with good results, especially the heifers accounted for this. The sows could uptake about half of their roughage intake as fresh grazed clover-grass, while grazing on the same plot the whole summer. Together with two of the researchers connected to the previous project (Viggo Danielsen and Karin Søgaard) in 2000 the mixed grazing was continued, and further developed. The grazing pasture was divided in three, and a rotation grazing system with sows and heifers was practiced.
5. The Pajbjerg plant breeding company started a field trial to monitor many varities of spring and winter cereals grown in the organic rotation systems. The main objective for this work is to find the species and varieties that are best suitable for organic cultivation. The trial is carried out in the pig rotation system and in the mixed rotation system. Anni Jensen, Pajbjerg Fonden, is reponsible for the project).
6. The Department of Variety Testing carries out field experiments on many different sites in Danmark. In 2000, 229 winter cereal parcels and 119 spring cereal parcels were laid out at Rugballegaard to test varieties grown under organic conditions.
7. Together with the Department of Variety Testing and the Danish Advisory system the Or-

ganic Experimental Station laid out a field trial with 33 varieties in spring and winter cereals and pies to measure the yields.
8. Together with the Danish Advisory System an experiment with catch crops in Maize for silage was carried out.
9. In 2001 a row soil steaming drilling device is being developed, experiments start in 2002.
10. In 2002 in all 14 experiments have been carried out in cooperation with the Danish Advisory System.
11. A new crop Quinoa was grown on experimental base on 0,5 ha.in 2002 The product can be used in feeding research.
12. A new crop "Chicory" was grown in 2002 to provide the product for a feeding research with young bulls.
13. Together with the department of farming systems and the Danish advisory system a field trial with the use of GPS positioned slurry was carried out in 2002.

The following activities are carried out on animals at Rugballegaard

1. In order prepare to start up a research project in organic milk production dealing with prolonged lactation and grazing habits of milking cows only fed with roughage, compared with part of the herd that is fed with both concentrates and roughage, the organic experimental station held part of the herd without concentrates. This work is done in close contact with the project leader Troels Kristensen.
2. Together with the Department of Agricultural Engineering a new stable for organic pig production is tested.
3. Research program PIGSYS, resource use, environmental impact and economy in organic pig production systems has begun in 2001 (John Hermansen)
4. OrganicPigFeed, pig feeding under organic conditions with emphasis on nutrient utilisation, product quality and health has begun in 2001. (José Fernandez)
5. A large developement project started in 2001, where new housing systems for organic slaughtering pigs, new grazing systems for sows and slaughtering pigs and animal welfare are the main topics. (John Hermansen)

H. Critical reflection on the project

A number of field experimental units were established in 1996 as part of the joint effort on organic farming research in Denmark coordinated by DARCOF. Under DARCOF-II these experimental units were collected within the same framework, the project EXUNIT. This has led to a better coordination of crop management and communication activities at the sites. However, the EXUNIT project also contained a considerable reduction in funding of the experimental units, which has led to a reduction in number of sites and in intensity of general measurements carried out.

The organic experimental units have been a valuable asset for the Danish organic farming research, because it has ensured that the experimental research has been carried out on sites with good organic management where the history of the site is also documented. Good experimental units should not only be managed organically, but also reflect the variation, farming practices, soils and climate. The organic experimental farm, Rugballegaard, also offers possibilities for studying interactions between plant and animal production.

Some of the experimental units have been designed as separate experiments, where the long-term effects of crop rotations, cover crops and animal manure are investigated. These experiments also function as experimental units, where specific experimental and project ac-

tivities focusing on interactions with soil fertility, cropping practice and cropping history are performed. Examples of this are the possibilities of exploiting residual nitrogen effects, the risk of detrimental soil compaction, the interaction of genetics and environment in relation to crop and cultivar choice, problems with establishment of cover crops, and occurrence of weeds and diseases.

There is an intensive use of the organic experimental units, both in DARCOF funded projects and in other projects, including EU-funded projects. Some of the experimental units currently have problems in offering sufficient space to host the projects. This has in a few cases led to establishment of organic farming experiments outside of the experimental units. There is therefore a need to adjust the crop rotations to better suit the need for current organic farming research activities. This actually means increasing the proportion of cereals and pulses in the crop rotations, and this has been the basis for adjusting the crop rotations in the EXUNIT-2 project.

The experimental units will over the coming years focus on two major areas of importance for the practical development in Danish organic farming:

- *Arable crop rotations without grass-clover*. It is the hypothesis that by optimal use of pulses and cover crops, a satisfactory production may be achieved in organic crop rotations with cereals/vegetables without grass-clover. The focus will primarily be on nitrogen dynamics and prevention and control of weeds, in particular perennial weeds.
- *Nitrogen dynamics in grazed grass-clover fields*. It is the hypothesis that there is a considerable nitrogen surplus on farms with grazed grass-clover fields. If this nitrogen is better exploited in the crop rotations, additional manure may be made available from such farms to be used in arable organic farming.

The experimental units must continuously be adjusted to match the changed in practical organic farming, or even better to anticipate such changes. A dialogue with the organic farming industry has therefore been initiated through the establishment of an external advisory board.

The experimental units has an important role in communicating results from the organic farming research to the industry. This is carried out through many activities at the experimental units, including field days, progammes in radio and TV, and papers in farmers magazines. A new activity has been to organise 3-day field days for advisors at the experimental units, and in 2003 this will be extended with internet-pages based on the results at the experimental units. These internet pages will be organised to primarily support the work of organic advisors and teachers, as a census has shown that farmers mainly get their information from other sources.

The EXUNIT project plans in collaboration with the BIOMOD project to organise an international workshop in spring 2004 on "*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

4.7 month scientific personnel (185,000 kr) and 45,000 kr in expenses (in total 230,000 kr) have been transferred from 2002 to 2003 in the EXUNIT project for completion of the publication of results from the first course of the crop rotation experiment (EXUNIT-WP6).

B. Budget for the whole project (1.000 DKK)

Total budget for EXUNIT

Year:	Consumption before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	39,1	16,2	15,1	6,0	0	76,5
Technical personnel	213,3	85,4	59,0	9,7	0	363,2

Year:	Consumption before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	1467	812	624	273	0	3176
Technical personnel	5045	2224	1652	281	0	9202
Other operational costs	1437	582	479	94	0	2592
Equipment						0
Others (please specify)						0
Direct costs	7949	3618	2756	648	0	14970
Indirect costs (20% of direct costs)	37	13	0	0	0	50
Total	7986	3631	2756	648	0	15020

Comments:
4.7 month scientific personnel (185,000 kr) and 45,000 kr in expenses (in total 230,000 kr) have been transferred from 2002 to 2003 in the EXUNIT project for completion of the publication of results from the first course of the crop rotation experiment (EXUNIT-WP6).

Total budget for EXUNIT-2

Year:	Consump-tion before 2002	Expected consump-tion 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	2,1	4,9	10,7	3,5	21,2
Technical personnel	0	4,6	26,7	79,6	3,5	114,4

Year:	Consump-tion before 2002	Expected consump-tion 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	84	208	486	166	944
Technical personnel	0	120	722	2296	106	3244
Other operational costs	0	55	175	451	41	722
Equipment						0
Others (please specify)						0
Direct costs	0	259	1105	3233	313	4910
Indirect costs (20% of direct costs)	0	18	36	36	0	90
Total	0	277	1141	3269	313	5000

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project Jørgen E. Olesen	Danish Institute of Agri-cultural Sciences		

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

EXUNIT Danmarks JordbrugsForskning

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	35.7	15,2	14,4	6,0	0	72,5
Technical personnel	206.9	83,0	58,1	9,7	0	353.5

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	1374	770	594	273	0	3011
Technical personnel	4893	2162	1628	281	0	8964
Other operational costs	1267	503	417	94	0	2281
Equipment						0
Others (please specify)						0
Direct costs	7534	3435	2639	648	0	14256
Indirect costs (20% of direct costs)		0	0	0	0	0
Total	7534	3435	2639	648	0	14256

Comments:

4.7 month scientific personnel (185,000 kr) and 45,000 kr in expenses (in total 230,000 kr) have been transferred from 2002 to 2003 in the EXUNIT project for completion of the publication of results from the first course of the crop rotation experiment (EXUNIT-WP6).

EXUNIT-2 Danmarks JordbrugsForskning

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0,5	3,2	8,3	3,5	15,5
Technical personnel	0	4,0	23,0	75,0	3,5	105,5

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	20	140	388	166	714
Technical personnel	0	106	635	2184	106	3031
Other operational costs	0	49	160	370	41	620
Equipment						0
Others (please specify)						0
Direct costs	0	175	935	2942	313	4365
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	175	935	2942	313	4365

Comments:

A. Budget for each participating institute (1.000 DKr)

EXUNIT KVL

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0.9	0,3	0	0	0	1,2
Technical personnel	4.5	1,5	0	0	0	6,0

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	33	12	0	0	0	45
Technical personnel	104	38	0	0	0	142
Other operational costs	46	17	0	0	0	63
Equipment						0
Others (please specify)						0
Direct costs	183	67	0	0	0	250
Indirect costs (20% of direct costs)	37	13	0	0	0	50
Total	220	80	0	0	0	300

Comments:

EXUNIT-2 KVL

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0,1	0,2	0,2	0	0,5
Technical personnel	0	0,6	3,7	3,7	0	8,0

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	4	8	8	0	20
Technical personnel	0	14	87	87	0	188
Other operational costs	0	1	10	11	0	22
Equipment						0
Others (please specify)						0
Direct costs	0	19	105	106	0	230
Indirect costs (20% of direct costs)	0	3	21	21	0	45
Total	0	22	126	127	0	275

Comments:

A. Budget for each participating institute (1.000 DKr)

EXUNIT Grønt Center

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	1,5	0,7	0,7	0	0	2,9
Technical personnel	1,9	0,9	0,9	0	0	3,7

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	60	30	30	0	0	120
Technical personnel	48	24	24	0	0	96
Other operational costs	124	62	62	0	0	248
Equipment						0
Others (please specify)						0
Direct costs	232	116	116	0	0	464
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	232	116	116	0	0	464

Comments:

EXUNIT-2 Grønt Center

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0	0	0,7	0	0,7
Technical personnel	0	0	0	0,9	0	0,9

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	0	0	30	0	30
Technical personnel	0	0	0	25	0	25
Other operational costs	0	0	0	65	0	65
Equipment						0
Others (please specify)						0
Direct costs	0	0	0	120	0	120
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	0	0	120	0	120

Comments:

A. Budget for each participating institute (1.000 DKr)

EXUNIT-2 Landbrugets Rådgivningscenter

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	1,5	1,5	1,5	0	4,5
Technical personnel	0	0	0	0	0	0

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	60	60	60	0	180
Technical personnel	0	0	0	0	0	0
Other operational costs	0	5	5	5	0	15
Equipment						0
Others (please specify)						0
Direct costs	0	65	65	65	0	195
Indirect costs (20% of direct costs)	0	15	15	15	0	45
Total	0	80	80	80	0	240

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Plantevækst og Jord

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	17,8	9,0	6,7	2,7	0	36,2
Technical personnel	115,8	48,0	34,8	0	0	198,6

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	676	525	278	120	0	1599
Technical personnel	2837	1249	975	0	0	5061
Other operational costs	531	221	138	0	0	890
Equipment						0
Others (please specify)						0
Direct costs	4044	1995	1391	120	0	7550
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	4044	1995	1391	120	0	7550

Comments:

1.7 month scientific personnel (68,000 kr) have been transferred from 2002 to 2003 in the EXUNIT project for completion of the publication of results from the first course of the crop rotation experiment (EXUNIT-WP6).

EXUNIT-2 Danmarks JordbrugsForskning, Afdeling for Plantevækst og Jord

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0,2	1,3	4,9	2,5	8,9
Technical personnel	0	2,2	12,2	48,2	3,0	65,6

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	8	64	235	121	428
Technical personnel	0	58	334	1404	89	1885
Other operational costs	0	37	70	226	35	368
Equipment						0
Others (please specify)						0
Direct costs	0	103	468	1865	245	2681
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	103	468	1865	245	2681

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Plantebeskyttelse

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	8,1	3,0	5,5	1,3	0	17,9
Technical personnel	36,6	16,1	13,3	0	0	66,0

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	295	117	222	59	0	693
Technical personnel	876	419	372	0	0	1667
Other operational costs	330	113	185	0	0	628
Equipment						0
Others (please specify)						0
Direct costs	1501	649	779	59	0	2988
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	1501	649	779	59	0	2988

Comments:

EXUNIT-2 Danmarks JordbrugsForskning, Afdeling for Plantebeskyttelse

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0,1	0,1	2,6	1,0	4,8
Technical personnel	0	0,6	2,6	18,6	0,5	22,3

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	4	43	116	45	208
Technical personnel	0	16	73	544	17	650
Other operational costs	0	4	7	59	6	76
Equipment						0
Others (please specify)						0
Direct costs	0	24	123	719	68	934
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	24	123	719	68	934

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Prydplanter og Vegetabilske Fødevarer

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	2,7	0,9	0	0	0	3,6
Technical personnel	26,4	8,5	0	0	0	34,9

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	98	34	0	0	0	132
Technical personnel	618	213	0	0	0	831
Other operational costs	218	75	0	0	0	293
Equipment						0
Others (please specify)						0
Direct costs	934	322	0	0	0	1256
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	934	322	0	0	0	1256

Comments:

EXUNIT-2 Danmarks JordbrugsForskning, Afdeling for Prydplanter og Vegetabilske Fødevarer

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0,1	0,7	0,7	0	1,5
Technical personnel	0	0,6	7,6	7,6	0	15,8

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	4	29	33	0	66
Technical personnel	0	16	211	219	0	446
Other operational costs	0	4	79	80	0	163
Equipment						0
Others (please specify)						0
Direct costs	0	24	319	332	0	675
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	24	319	332	0	675

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Jordbrugsteknik

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	5,1	2,4	2,2	2,0	0	11,7
Technical personnel	23,9	10,4	10,0	9,7	0	54,0

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	188	94	94	94	0	470
Technical personnel	562	281	281	281	0	1405
Other operational costs	188	94	94	94	0	470
Equipment						0
Others (please specify)						0
Direct costs	938	469	469	469	0	2345
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	938	469	469	469	0	2345

Comments:

EXUNIT-2 Danmarks JordbrugsForskning, Afdeling for Jordbrugsteknik

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	0	0,1	0,1	0,1	0	0,3
Technical personnel	0	0,6	0,6	0,6	0	1,8

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	0	4	4	4	0	12
Technical personnel	0	16	17	17	0	50
Other operational costs	0	4	4	5	0	13
Equipment						0
Others (please specify)						0
Direct costs	0	24	25	26	0	75
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	24	25	26	0	75

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Jordbrugssystemer

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months						
Scientific personnel	3,0	0	0	0	0	3,0
Technical personnel	0	0	0	0	0	0

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries						
Scientific personnel	117	0	0	0	0	117
Technical personnel	0	0	0	0	0	0
Other operational costs	0	0	0	0	0	0
Equipment						0
Others (please specify)						0
Direct costs	117	0	0	0	0	117
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	117	0	0	0	0	117

Comments:

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

EXUNIT Danmarks JordbrugsForskning og Grønt Center

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months Scientific personnel Technical personnel						

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries Scientific personnel Technical personnel						
Other operational costs						
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	1558	715	542	130	0	2945
Total	1558	715	542	130	0	2945

Comments:

EXUNIT-2 Danmarks JordbrugsForskning og Grønt Center

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months Scientific personnel Technical personnel						

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries Scientific personnel Technical personnel						
Other operational costs						
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	0	35	187	588	63	873
Total	0	35	187	588	63	873

Comments: