Danish Research Centre for Organic Farming

Midterm Status Report 2003 and Application for Continuation in 2004

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

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

Research professor Jørgen E. Olesen
Danish Institute of Agricultural Sciences
Department of Agroecology
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

Dansk Landbrugsrådgivning, Landscentret
Udkærsvej 15, Skejby
8200 Århus N
Tlf. 87405000
Fax. 87405010

5. Other project staff

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

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

Seniorforsker Jørgen Eriksen (JE), Afd. for Jordbrugsproduktion og Miljø, 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 Jordbrugsproduktion og Miljø, 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 Flakke-

bjerg, 4200 Slagelse, Tlf. 58113394, Fax. 58113301, E-mail: IlseA.Rasmussen@agrsci.dk

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

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

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. Six years results from three systems, hkg of DM/ha. The mean is for 1997-2002 only.

	1997	1998	1999	2000	2001	2002	Mean
Pig system							
Average of cereals/peas and lupin	41	40	42	42	30	28	39
Average of roughage	62	21	18	46	47	41	43
Total (average)	49	36	38	43	35	31	40
Dairy system							
Average of cereals/peas and lupin	34	35	36	50	36	37	39
Average of roughage	74	62	84	59	74	62	69
Total (average)	51	52	73	56	62	57	59
Mixed system							
Average of cereals/peas and lupine	43	36	42	51	35	33	41
Average of roughage	83	83	90	70	65	77	78
Total (average)	71	65	68	62	48	51	61

At Rugballegaard the years 2002 and 2003 has been used to experiment with some new crops, without changing the overall rotation system of the three systems. The systems are fertilized only with the manure from the stock related to the systems. All practical measures are according to the organic standards, described in the governmental Plant Directorate. The new crops are: lupins, sugar beets, chicory, maize for silage and quinoa, where the last was only grown in a small scale (1 ha). In order to anticipate the demonstration and communication demands, there have been a large amount of crops present at the experimental station Rugballegaard.

Unfortunately the tendency of lower yields throughout the years continues (Table 2). One of the reasons is the experimenting with new crops, another is the failure of for instance sugar beets, with no harvest in 2002. There is also an increasing problem with couch grass (Agropyron repens) and thistles (Cirsium arvense).

Jyndevad

The organic crop rotation of the experimental area at Jyndevad was changed in 2003 into three different rotations. Table 3 shows the rotations as they will be after a short conversion period of two years. Rotation 1 without any grass-clover aims at producing cash crops, crop rotation 2 is a dairy rotation and in the years with grass-clover there will be grazing cows. Rotation 3 is a continued grass-clover with grazing cows. These three systems aims at establish different fertility levels, which can be valuable in e.g. N-studies.

Table 3. The three rotations at Jyndevad

Crop rotation 1	Crop rotation 2	Crop rotation 3
All fields represented each year	Only 1 field	Only 1 field
1. Potatoes. 2. Field beans; red clover catch crop. 3. Spring oat; rye/ winter vetch catch crop. 4. Pea/spring barley; red clover catch crop 5. Spring barley; ryegrass/clover catch crop.	1. 1 year grass-glover 2. 2. year grass-clover 3. Barley wholecrop	Continued grass-clover with grazing cows.

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 ended by 2002. However, it has been 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. There is a great demand of fields for 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, however in 2003 the biomass (but not the number) of weeds in winter wheat and spring barley was greater than ever before. The number and biomass of perennial weeds, especially Canadian thistle (Cirsium arvense) has been increasing.

In 2003, the sugar beet field has been replaced with a cereal (spring barley) field to accommodate needs for experimental area.

KVL Taastrup

There are two experimental areas at KVL-Taastrup, the CFE-system and the 5-year 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. Until 2002 the crop rotation consisted of cereals, grass-clover and fodder beets – as normally grown by cattle farmers. General practice has changed towards less fodder beets and consequently the crop rotation in CFE has been changed. The CFE-system now consists of a system with two years of grass-clover and two years of cereals, and no organic fertiliser will be supplied.

The 5-year crop rotation was a cattle farm system as well consisting of cereals, fodder beets and grass clover. It has now been changed into a system representative of an arable organic farm with large amount of N-fixating crops and no supply of fertiliser: 4 years of cereals and pulses, and one year of red clover for seed production.

Årslev, vegetables

The crop rotation has been changed since last year. There is now no full year green manure in the rotation. Instead an extra year of cereals has been included and the diversity increased. Until now there have been two years of cereals, both spring barley. Now there are three years of cereals, including barley, oats and winter rye. Cereals are grown every second year, and cereals with undersown legumes will be the precrop for all the vegetables in the rotation. The changes will not be fully implemented until next year, so no conclusions can be drawn yet.

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. In 2003 the cereal yields were almost as high as in the first years, probably due to the very dry winter leading to very small N leaching losses.

There has been no consistent trend in the yields of the rotation. The yield of peas is 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, and it is the main reason behind the changes in the crop rotation mentioned above.

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. Irrespective 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.

Årslev, fruit and berries

The trials planted in the research area are shown in Table 4. Only the black currant trials have been 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).

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

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

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.
- In 2002 the pastures of grass-clover and ryegrass were ploughed after 1, 2 and 8 production years. The pre-crop effect ranged from about 70 kg N/ha following 1 year of pasture to 100-120 kg N/ha following 8 years of grazed pasture with the highest pre-crop effect following ryegrass. In the following winter (2002-2003) nitrate losses were smallest following ploughing of young grass-clover swards only grazed for 1 year (6 kg NO_3-N/ha) and highest following ploughing of older swards grazed for 2 or 8 years (35 kg NO_3-N/ha).
- Following the ploughing of the above mentioned grasslands spring wheat was grown with different N-applications in slurry (0, 115 and 230 kg total-N at sowing and a split application with 170 kg total N at sowing and 60 kg at heading). The yield effects of slurry were small, but the protein content was much increased by slurry application. There was no effect of split application on protein content.

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 again 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 relevant for current organic farming practices.

Table 5. The Foulum dairy crop rotation from 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	

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

In a recently submitted paper on the nitrate leaching from the rotation, the following conclusion were drawn: The experiment confirmed the extreme importance of the management of grassland N in dairy crop rotations as the highest nitrate leaching losses were after the three crops following ploughing of grass-clover. However, this was manageable as the replacement of winter wheat and bare soil by ryegrass catch crops in the two winters following ploughing of the pasture decreased nitrate leaching considerably (see Figure 1). Because of the huge pulse of N from the ploughing of grassland nitrate leaching was not related to type of organic fertiliser (slurry or FYM from deep litter housing) at the crop rotation level or the livestock density of the farm (0.7 or 1.4 LU ha^{-1}) and also yield responses were modest.

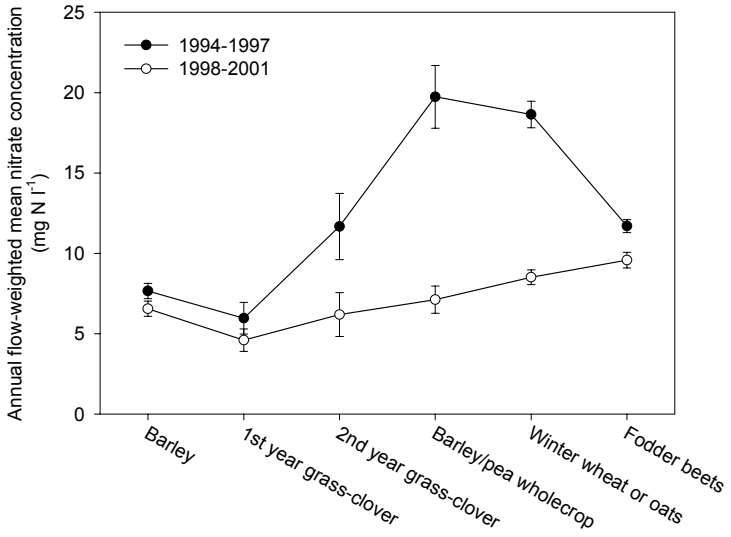

Figure 1. Annual flow-weighted mean nitrate concentration (nitrate leaching per volume drainage) in two periods of the crop rotation. In 1998-2001 winter wheat was replaced by oats with a ryegrass catch crop. Error bars: ±SE.

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 were revised after the first rotation and

the revised crop rotations for 2001-2004 is shown in Table 6. 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 2001-2004. The sign ':' indicates that a grass-clover ley, or a clover, ryegrass or rye-grass/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

Table 7 shows the average rotation yields for the first two years of the revised rotation. There was a lower yield at Jyndevad in rotation 2 compared with rotation 1, which is caused by a lower yield in lupin compared with pea/barley, and in winter rye compared with spring oats. There were only small yield benefits from the use catch crops at Jyndevad in these rotations.

In the first four years of the CRE experiment there were clear yield advantages from using rotation 4 compared with rotation 2 at Foulum and Flakkebjerg. This picture is no longer so clear. Without catch crops and manure there was only a small yield advantage for rotation 4 at Foulum, but a considerable yield reduction at Flakkebjerg. Both sites showed a considerable yield advantages of 1.5 t/ha for rotation 4 compared with rotation 2 in the treatment with manure and catch crops.

There were only small yield benefits from cover crops in rotation 2, whereas the yield increase from catch crops was about 1.0 t/ha in rotation 4 as an average over all crops in the rotation. It is the use of nitrogen fixing catch crops (white and red clovers) in rotation 4 that has mainly contributed to this.

Table 7. Average annual grain yields (t/ha) for the crop rotations in 2001 and 2002. The yield is calculated as an average of the whole rotation area, i.e. the area of grass-clover in rotations 1 and 2 were included with zero yield.

Site	Rotation	Without manure		With manure	
		- CC	+ CC	- CC	+CC
Jyndevad	1	2.5	2.7	3.2	3.2
	2	1.8	1.7	2.3	2.6
Foulum	2	3.1	3.2	3.8	3.6
	4	3.5	4.5	4.7	5.3
Flakkebjerg	2	2.9	2.9	3.3	3.3
	4	2.0	3.0	3.4	4.8
Holeby	2		3.5		
	4		3.5		

The concentration of nitrate and potassium is measured using permanently installed ceramic suction cups in several plots in the rotations. Figure 2 shows the concentrations for one of the fields in rotation 1 at Jyndevad. There was a large peak of nitrate concentration in the grass-clover in 2001. This peak coincided with a summer fallow in the grass-clover. This summer fallow has been introduced at Jyndevad to control couch grass. However, one large disadvantage of this summer fallow is the considerable risk of increased N leaching. Figure 2 also shows that catch crops reduces soil nitrate concentrations considerably.

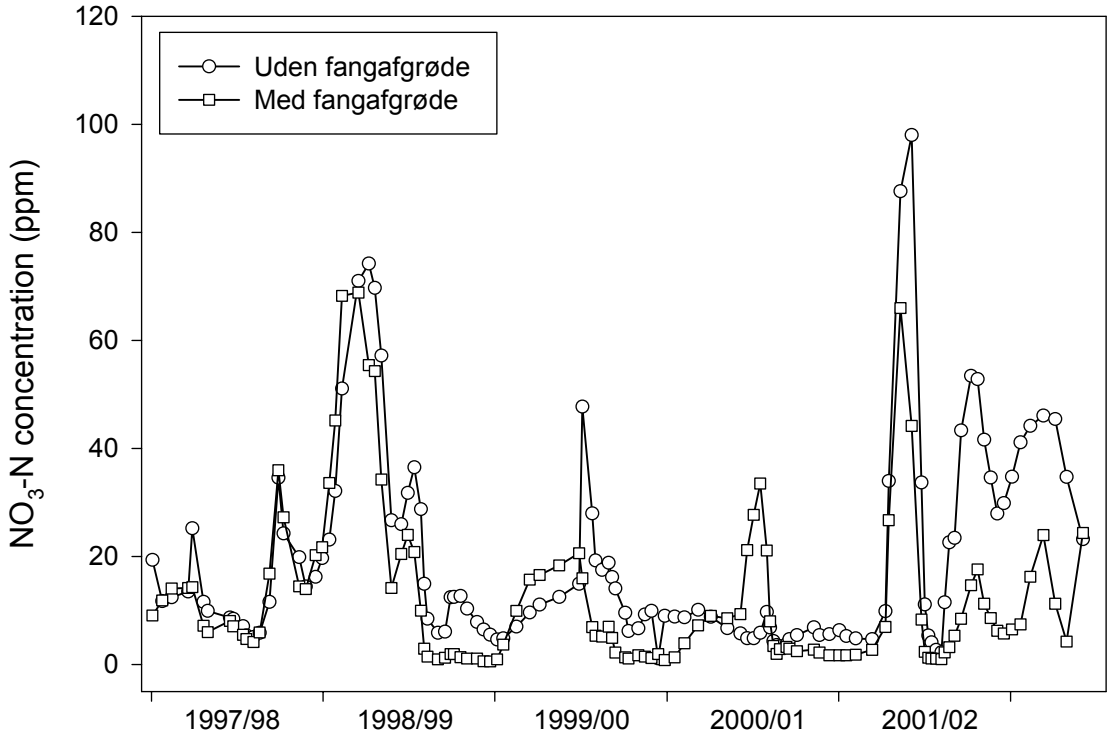

Figure 2. Nitrate-N concentration at Jyndevad in field 2 of rotation 1 (grass-clover, sprint wheat, lupin, spring barley, grass-clover, oats) with manure and with/without catch crops.

The potassium concentrations in the soil water have been declining at both Jyndevad and Foulum (Fig. 3). The results indicate that concentrations may have stabilised at Jyndevad,

whereas there still is a declining trend at Foulum.

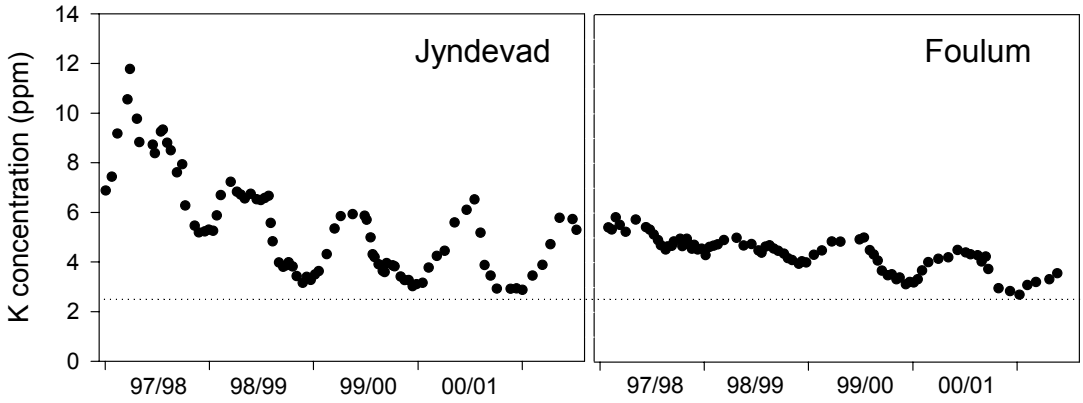

Figure 3. Average potasium concentations in soil water at Jyndevad and Foulum.

Perennial weeds are becoming an increasing problem at all sites. Thistles dominate at Flakkebjerg and couch grass at Jyndevad. However, several other perennial weed species are also present, although often only at one site and in one or a few plots. There are indications of effects of crop rotations on infestation with these perennial weeds. However, the picture is not clear because weed control treatments have been applied targeting the plots and treatment combinations where specific perennial weed problems have occurred.

The mechanical weed control treatments seem to have had some success, but the perennial weed problem still remains. In some cases the harrowing in the autumn to control couch grass may even enhance the problems, by increasing the risk of nitrate leaching losses and thus reducing the amount of nitrogen available for the following crop, resulting in poor crop growth and poor competition against the couch grass. The effect of autumn weed harrowing on yield of the following spring barley crop is illustrated in Table 8 for data for Jyndevad in 2002. Weed harrowing greatly reduced yield of the following spring barley crop in the situation without catch crop, but there was no negative effect where a catch crop had been used to reduced leaching following the harrowing.

Mechanical weed control can result in a vicious circle with increasing N losses, reduced yield and increasing weed problems. To better investigate the effect of the systems effects on perennial weeds, it was decided in February 2003 to reduce mechanical weed control to a minimum in the CRE experiment. This should for the remaining part of the experiment give some indications on the effects of crop rotation, catch crops and manure on perennial weeds.

Table 8. Effect of autumn weed harrowing to control couch grass on yield of the following spring barley crop (t/ha).

	Catch crop	
Autumn weed harrowing	Without	With
Without	2.9	2.8
With	2.1	2.9

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 2003 as well as in 2002 a course was organised by the Danish Agricultural Advisory Centre. The course "Organic Field-days" was held at the Research Centre Årslev with 25 participants, who all were agricultural advisors in organic farming. 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 Årslev 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 participants has expressed their attitude to "Organic Field Days" as "very satisfactory" in the evaluation.

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. A new meeting will be held in late 2003 to discuss the future of the long-term trials in the project.

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	delivered
2. Planning of field days	2000-2004	delivered
3. Ensure high experimental standards	2000-2004	delivered
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	delivered
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	delivered
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	delivered
Milestones		
1. End of external funding	2002/12	delivered

** 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	delivered
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	delivered

** 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	delivered
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	delivered
2. End of external funding	2002/12	delivered

** 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	delivered
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	delivered
7. Farmers journal article	2002/12	**postponed?**
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	delivered
2. Provide workshop facilities	2000-2003	delivered
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	delivered
2. Make whole-farm assessments	2000-2004	delivered
3. Demonstration and communication	2000-2004	delivered
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	delivered
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	delivered

** 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	delivered
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	postponed

** 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 late 2003/early 2004.

In EXUNIT-2 WP3 it was anticipated that a web-site should have been launched by October 2002. This has been postponed to the end of 2003, due to other obligations by the executive project staff member. An initial planning of training of the staff member has been conducted

as he has passed an Internet writing course. A concept for Internet presentation has also been developed. It is regarded, that the EXUNIT activities and result must be presented in a "story-telling-universe" in order to attract potential readers among organic farmers, advisers and other with interest. This strategy is on the contrary to the typical very long and text heavy articles, that usually is presented on the DARCOF website. The first articles and structure of the EXUNIT-universe will be uploaded during the second half of 2003 and completed during 2004.

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. (2003). Exchangeable potassium and potassium balances in organic crop rotations on a coarse sandy soil. *Soil Use and Management* **19**, 96-103. *

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. **

Cirujeda, A., Melander, B., Rasmussen, K. & Rasmussen, I.A. (2003): Relationship between speed, soil movement into the cereal row and intra-row weed control efficacy by weed harrowing. Weed Research 43(4), 285-296. **

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., Askegaard, M. & Kristensen, K. (submitted). Nitrate leaching from an organic dairy crop rotation; the effect of manure type, N-input and improved crop rotation. *Soil Use and Management.*

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. **

Grundy, A.C., Peters, N.C.B., Rasmussen, I.A., Hartmann, K.A., Sattin, M., Andersson, L., Mead, A., Murdoch, A.J., Forcella, F. (2003): Emergence of Chenopodium album and Stellaria media of different origins under different climatic conditions. Weed research 43(3), 163-176.**

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. **

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. (2002). Whole-rotation dry matter and nitrogen grain yields from the first course of an organic farming crop rotation experiment. *Journal of Agricultural Science, Cambridge* **139**, 361-370.

Rasmussen, J. (2003). Punch planting, flame weeding and stale seedbed for weed control in row crops. *Weed Research* **43** (in press).**

2. Presentations at congresses, symposiums etc

Askegaard, M., Olesen, J.E. & Rasmussen, I.A. (2002). 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. **

Grundy, A.C., Peters, N.C.B., Rasmussen, I.A., Hartmann, K.M., Sattin, M., Andersson, L., Mead, A., Murdoch, A.J. & Forcella, F. (2002): Emergence of *Chenopodium album* and *Stellaria media* under different climatic conditions. In: 12th EWRS (European Weed Research Society) Symposium 2002, Wageningen, 264-265.**

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.A. (2002). 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., Askegaard, M. & Rasmussen, I.A. (2002). Økologisk planteavl uden husdyr. I Eltun, R. (ed.): Næringsforsyning i økologiske dyrkningssystem med lite husdyrgjødsel. *Planteforsk Grønn forskning* 34/2002, 20-24.

Olesen, J.E., Askegaard, M. & Rasmussen, I.A. (2003). Crop production and N leaching in arable organic farming. In Niemeläinen, O. & Topi-Hulmi, M. (Eds.) Proceedings of NJF's 22nd Congress "Nordic Agriculture in Global Perspective". p. 195.

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.

Oudshoorn, F.W. (2002). Rugballegaard, the Danish Organic Experimental Station for Dairy and Pig Production,System Research, Five Years of Experience and Results. 14 th International IFOAM Scientific Conference, Vancover.

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.
Askegaard, M., Olesen, J.E. & Rasmussen, I.A. (2003). Sædskifterne bliver mere selvkørende. *Økologisk Jordbrug* **23(288)**, 13.
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. (2002). Forberedelser til en ny vækstsæson. *Økologisk Jordbrug* **273**, 6.
Olesen, J.E. (2003). Fabelagtig vækstsæson. *Økologisk Jordbrug* **295**, 8.
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.
Olesen, J.E., Rasmussen, I.A. & Askegaard, M. (2003). Sådan er det gået med forsøgssædskifterne. *Økologisk Jordbrug* **23(288)**, 12.
Olesen, J.E. & Thorup-Kristensen, K. (2003). Vælg det rigtige tidspunkt til nedpløjning af efterafgrøden. *Agrologisk Tidsskrift Marken* **21(3)**, 26-27.
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. (2003). Nyt fra de økologiske sædskifteforsøg. Økologisk Jordbrug **289**, 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.
Rasmussen, I.A. & Melander, B. (2001): Ukrudtsbekæmpelse i økologisk dyrket vintersæd: resultater og erfaringer. Forskningsnytt om økologisk landbruk i Norden, 6, 9-11. **
Rasmussen, I.A., Thomsen, H., Askegaard, M. & Olesen, J.E. (2003). Kvik volder kvaler. *Økologisk Jordbrug* **23(288)**, 13.
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.
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., (2003). Efterafgrøder med mange formål. *Økologisk Jordbrug* **23(285)**, 6.

4. Other presentations at meetings, field days etc.

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. **

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 and in May 2003 at Årslev. 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).

Bente Føreid. Temperate low input agroforestry for carbon sequestration (organic crop rotation and CFE system at KVL-Taastrup).

Bernd Kuemmel. CFE Systems - An integrated analysis of the economic and energetical balances of a combined food and energy (CFE) system (CFE system at KVL-Taastrup).

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).

Jens Prior Hansen (2003-2004): Residual effect of ploughing out grasslands as a function of grassland age, management and fertilization. (Residual effects of pasture – Foulum).

G. National and international cooperation

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

WP2. Workshop areas at 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). It is also currently being used for experiments on timing of N-release after ploughing-in grass-clover and catch crops.

The dairy crop rotation at Foulum has primarily been used for the nutrient cycling experiment described in WP5. The dairy crop rotation is furthermore used by the project "Characteristics of Spring Barley Varieties for Organic Farming (BAR-OF)" (work package Nutrient Acquisition and Crop Performance) funded by Research in organic farming 2000-2005 (DARCOF II). The aim is to investigate the performance of barley varieties and variety mixtures in growth and yield characteristics, weed competition and disease resistance. Seasonal crop growth is followed by reflectance measurements and root development is determined by minirhizotrones.

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 is 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 is a 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.

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.

At KVL-Taastrup activities in 2003 has intercropping studies (Henrik Haugaard-Nielsen) and N studies (Henning Høgh Jensen) in the CFE-system under DARCOF project GENESIS and EU funded project called INTERCROP.

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).
- Samplings and measurements in winter wheat crops at Foulum and Flakkebjerg to determine arthropods (Gabor Lövei).

WP7. The organic experimental farm, Rugballegaard

The following projects are carried out in the fields at Rugballegaard in 2003

1. In cooperation with the extension services in Denmark, som field experiments were carried out concerning: variety testing, growing of maize for silage, summer wheat, fertilising with manure and catch crops. The results are published in the survey of Plant experiments 2002.
2. Torben Sole Madsen (PhD) continues his research on organic ploughing strategies.
3. Other small projects concerning soil tillage were carried out.

The following activities are carried out on animals at Rugballegaard

1. Organic milk production.(FØJO, Troels Kristensen) Involves 60 cows, 30 ha of grazing area, production of oats and roughage.
2. SUSPORKQUAL (Jose´ Fernandez) Involves slaughtering pigs, roughage, lupines and feeding strategies.
3. PIGSYS (FØJO, John Hermansen) Involves slaughtering pigs in the field, feeding strategies.
4. ORGANIC PIGFEED (FØJO, Viggo Danielsen) Involves slaughtering pigs and sows in the field, roughage production and the production of protein crops
5. Animal welfare in Organic Pig Production (Bent Hindrup Andersen) Involves alternative housing, male pig production.
6. Animal welfare, supplement (Laurits Lydehøj Hansen) Involves different races of pig breeds to diminish bad smells in slaughtered male pigs.
7. Information about organic pig production focussed on the future consumer (Frank Oudshoorn).

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 activities 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 these projects claim that they due to the research questions investigated need to exceed the current rules set out in by the organic farming standards. Recently this has led to discussions with respect to the activities of the BAROF project at Flakkebjerg, where pesticides were used for various reasons. It has not been possible in the EXUNIT project to provide sufficient guidance on this as the decisions on this have been made on at a very decentralised level, i.e. often within the projects. However, we see it as an obligation in the future to provide a better guidance on when and how to apply non-organic standard measures in the workshop facilities. It should of course be noted that such activities cannot be included at Rugballegaard, which is organically certified. However, there are in some cases good scientific reasons for exceeding the standards, but a firm balance needs to be made.

Within the Danish Institute of Agricultural Sciences there has been a drastic change in cost assessments, which has revealed the real costs of carrying out both field and animal experiments. The actual costs far exceed what is contributed through the funding of both EXUNIT and other dedicated experiments. This poses a threat to the continuation of the experiments, in particular for those related to animals, animal feeding, behaviour and welfare, which have been shown to be particularly expensive. There is thus a need to thoroughly evaluate the future need for the organic experimental facilities. We aim to contribute to this over the next year and this will be a topic for discussions with the external advisory group.

The EXUNIT project plans in collaboration with the BIOMOD project to organise an international workshop in autumn 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 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	55,3	13,7	7,4	0	0	76,5
Technical personnel	298,7	59,0	9,7	0	0	363,2

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	2279	571	326	0	0	3176
Technical personnel	7269	1652	281	0	0	9202
Other operational costs	2019	479	94	0	0	2592
Equipment						0
Others (please specify)						0
Direct costs	11567	2703	701	0	0	14970
Indirect costs (20% of direct costs)	50	0	0	0	0	50
Total	11617	2703	701	0	0	15020

Comments:
1.4 month scientific personnel (53,000 kr) have been transferred from 2003 to 2004 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 2003	Expected consump-tion 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	2,1	4,9	10,7	3,5	0	21,2
Technical personnel	4,6	26,7	79,6	3,5	0	114,4

Year:	Consump-tion before 2003	Expected consump-tion 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	84	208	486	166	0	944
Technical personnel	120	722	2296	106	0	3244
Other operational costs	55	175	451	41	0	722
Equipment						0
Others (please specify)						0
Direct costs	259	1105	3233	313	0	4910
Indirect costs (20% of direct costs)	18	36	36	0	0	90
Total	277	1141	3269	313	0	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 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	50,9	14,0	7,4	0	0	72,5
Technical personnel	289,9	58,1	9,7	0	0	353.5

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	2144	541	326	0	0	3011
Technical personnel	7055	1628	281	0	0	8964
Other operational costs	1770	417	94	0	0	2281
Equipment						0
Others (please specify)						0
Direct costs	10969	2586	701	0	0	14256
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	10969	2586	701	0	0	14256

Comments:
1.4 month scientific personnel (53,000 kr) have been transferred from 2003 to 2004 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 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0,5	3,2	8,3	3,5	0	15,5
Technical personnel	4,0	23,0	75,0	3,5	0	105,5

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	20	140	388	166	0	714
Technical personnel	106	635	2184	106	0	3031
Other operational costs	49	160	370	41	0	620
Equipment						0
Others (please specify)						0
Direct costs	175	935	2942	313	0	4365
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	175	935	2942	313	0	4365

Comments:

A. Budget for each participating institute (1.000 DKr)

EXUNIT KVL

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	1,2	0	0	0	0	1,2
Technical personnel	6	0	0	0	0	6,0

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	45	0	0	0	0	45
Technical personnel	142	0	0	0	0	142
Other operational costs	63	0	0	0	0	63
Equipment						0
Others (please specify)						0
Direct costs	250	0	0	0	0	250
Indirect costs (20% of direct costs)	50	0	0	0	0	50
Total	300	0	0	0	0	300

Comments:

EXUNIT-2 KVL

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0,1	0,2	0,2	0	0	0,5
Technical personnel	0,6	3,7	3,7	0	0	8,0

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	4	8	8	0	0	20
Technical personnel	14	87	87	0	0	188
Other operational costs	1	10	11	0	0	22
Equipment						0
Others (please specify)						0
Direct costs	19	105	106	0	0	230
Indirect costs (20% of direct costs)	3	21	21	0	0	45
Total	22	126	127	0	0	275

Comments:

A. Budget for each participating institute (1.000 DKr)

EXUNIT Grønt Center

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	2,2	0,7	0	0	0	2,9
Technical personnel	2,8	0,9	0	0	0	3,7

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	90	30	0	0	0	120
Technical personnel	72	24	0	0	0	96
Other operational costs	186	62	0	0	0	248
Equipment						0
Others (please specify)						0
Direct costs	348	116	0	0	0	464
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	348	116	0	0	0	464

Comments:

EXUNIT-2 Grønt Center

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0	0	0,7	0	0	0,7
Technical personnel	0	0	0,9	0	0	0,9

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	0	0	30	0	0	30
Technical personnel	0	0	25	0	0	25
Other operational costs	0	0	65	0	0	65
Equipment						0
Others (please specify)						0
Direct costs	0	0	120	0	0	120
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	0	0	120	0	0	120

Comments:

A. Budget for each participating institute (1.000 DKr)

EXUNIT-2 Landbrugets Rådgivningscenter

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	1,5	1,5	1,5	0	0	4,5
Technical personnel	0	0	0	0	0	0

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	60	60	60	0	0	180
Technical personnel	0	0	0	0	0	0
Other operational costs	5	5	5	0	0	15
Equipment						0
Others (please specify)						0
Direct costs	65	65	65	0	0	195
Indirect costs (20% of direct costs)	15	15	15	0	0	45
Total	80	80	80	0	0	240

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Jordbrugsproduktion og Miljø

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	26,8	5,3	4,1	0	0	36,2
Technical personnel	163,8	34,8	0	0	0	198,6

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	1201	225	173	0	0	1599
Technical personnel	4086	975	0	0	0	5061
Other operational costs	752	138	0	0	0	890
Equipment						0
Others (please specify)						0
Direct costs	6039	1338	173	0	0	7550
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	6039	1338	173	0	0	7550

Comments:
1.4 month scientific personnel (53,000 kr) have been transferred from 2003 to 2004 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 Jordbrugsproduktion og Miljø

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0,2	1,3	4,9	2,5	0	8,9
Technical personnel	2,2	12,2	48,2	3,0	0	65,6

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	8	64	235	121	0	428
Technical personnel	58	334	1404	89	0	1885
Other operational costs	37	70	226	35	0	368
Equipment						0
Others (please specify)						0
Direct costs	103	468	1865	245	0	2681
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	103	468	1865	245	0	2681

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Plantebeskyttelse

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	11,1	5,5	1,3	0	0	17,9
Technical personnel	52,7	13,3	0	0	0	66,0

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	412	222	59	0	0	693
Technical personnel	1295	372	0	0	0	1667
Other operational costs	443	185	0	0	0	628
Equipment						0
Others (please specify)						0
Direct costs	2150	779	59	0	0	2988
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	2150	779	59	0	0	2988

Comments:

EXUNIT-2 Danmarks JordbrugsForskning, Afdeling for Plantebeskyttelse

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0,1	1,0	2,6	1,0	0	4,8
Technical personnel	0,6	2,6	18,6	0,5	0	22,3

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	4	43	116	45	0	208
Technical personnel	16	73	544	17	0	650
Other operational costs	4	7	59	6	0	76
Equipment						0
Others (please specify)						0
Direct costs	24	123	719	68	0	934
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	24	123	719	68	0	934

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Prydplanter og Vegetabilske Fødevarer

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	3,6	0	0	0	0	3,6
Technical personnel	34,9	0	0	0	0	34,9

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	132	0	0	0	0	132
Technical personnel	831	0	0	0	0	831
Other operational costs	293	0	0	0	0	293
Equipment						0
Others (please specify)						0
Direct costs	1256	0	0	0	0	1256
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	1256	0	0	0	0	1256

Comments:

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

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0,1	0,7	0,7	0	0	1,5
Technical personnel	0,6	7,6	7,6	0	0	15,8

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	4	29	33	0	0	66
Technical personnel	16	211	219	0	0	446
Other operational costs	4	79	80	0	0	163
Equipment						0
Others (please specify)						0
Direct costs	24	319	332	0	0	675
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	24	319	332	0	0	675

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Jordbrugsteknik

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	7,5	2,2	2,0	0	0	11,7
Technical personnel	34,3	10,0	9,7	0	0	54,0

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	282	94	94	0	0	470
Technical personnel	843	281	281	0	0	1405
Other operational costs	282	94	94	0	0	470
Equipment						0
Others (please specify)						0
Direct costs	1407	469	469	0	0	2345
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	1407	469	469	0	0	2345

Comments:

EXUNIT-2 Danmarks JordbrugsForskning, Afdeling for Jordbrugsteknik

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	0,1	0,1	0,1	0	0	0,3
Technical personnel	0,6	0,6	0,6	0	0	1,8

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	4	4	4	0	0	12
Technical personnel	16	17	17	0	0	50
Other operational costs	4	4	5	0	0	13
Equipment						0
Others (please specify)						0
Direct costs	24	25	26	0	0	75
Indirect costs (20% of direct costs)	0	0	0	0	0	0
Total	24	25	26	0	0	75

Comments:

B. Budget for each participating department (1.000 DKK)

EXUNIT Danmarks JordbrugsForskning, Afdeling for Jordbrugssystemer

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

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries Scientific personnel Technical personnel						
Other operational costs						
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	2273	542	130	0	0	2945
Total	2273	542	130	0	0	2945

Comments:

EXUNIT-2 Danmarks JordbrugsForskning og Grønt Center

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

Year:	Consump-tion before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries Scientific personnel Technical personnel						
Other operational costs						
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)	35	187	588	63	0	873
Total	35	187	588	63	0	873

Comments: