Danish Research Centre for Organic Farming

Progress Report 2004 and Application for Continuation in 2005

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

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1. Research program

Research in organic farming 2000-2005 (DARCOF II)

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2. Project title and number

Nitrate leaching from dairy farming. Effect of grassland composition and frequency. (I.15)

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3. Head of project

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4. Participating institutes

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6. Project period (month, year)

Start of project: 01-2003
End of project: 12-2006

7. Description of the project, its results and progress, and application for continuation in 2005.

A. Project summary

In nitrate vulnerable zones with agricultural production organic dairy farming may present an opportunity to reduce nitrate leaching if grassland N is efficiently utilised. The objective of the project is to determine the importance of the grassland composition and frequency in the crop rotation for residual effects on yield and nitrate leaching during grazing and following ploughing in order to 1) increase the total N use efficiency of the crop rotation and reduce N leaching losses from dairy crop rotations, 2) suggest specific changes to management and rotation, that may be carried out in e.g. nitrate vulnerable zones within the short term, and 3) establish a scientific sound basis for giving advise on these matters in both organic and conventional farming. The work includes determination of precrop effect and nitrate leaching following ploughing of grassland as affected by grassland frequency in the crop rotation and with comparison between grass-clover and fertilised pure ryegrass.
The results from the experiment are relevant for planning organic crop rotations, especially in nitrate vulnerable zones. The relevance of this type of information increases with the development towards increasing farm size. On large farms grazing on fields distant to farm buildings is more difficult resulting in a high grassland frequency in the rotation near the farm and a cash-crop rotation furthest away. It is important to determine N utilisation and environmental consequences of this. The results are also relevant for conventional farmers having ryegrass as the experiment includes a comparison between grass-clover and ryegrass.

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

No.	Work package title	Participants*	Budget (1.000 DKK)	Start	End	Deliverable no(s):
1	Determination of precrop effects and nitrate leaching of grazed grassland rotations	JE, EMH	900	04/03	01/06	1, 2
2	Nitrate leaching on coarse sandy soils	EMH, JE	1.190	01/03	04/06	3
3	SOAR Ph.D. study: Mineralisation of grassland nitrogen	HHJ, JR	200	07/03	07/06	4, 5
4	Optimising the N Cycle of organic dairy farms	JE, EMH, JEO, ISK, MA, HHJ	100	04/03	12/06	6, 7
Total			2.390			

* Responsible participants are underlined

B. Objectives and expected achievements

The objective of the project is to determine the importance of the grassland composition and frequency in the crop rotation for residual effects on yield and nitrate leaching during grazing and following ploughing in order to:
- increase the total N use efficiency of the crop rotation and reduce N leaching losses from dairy crop rotations
- suggest specific changes to management and rotation, that may be carried out in e.g. ni-

trate vulnerable zones within the short term, and

- establish a scientific sound basis for giving advise on these matters in both organic and conventional farming.

C. Midterm results and progress

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

<u>WP1: Determination of precrop effects and nitrate leaching of grazed grassland rotations</u>

The experimental area in Foulum for investigating residual effects of grassland hosts this part of the project. Over the last 8 years, three crop rotations have been build up with different frequency of grazed grassland (Table 1) including both unfertilised grass-clover and fertilised pure ryegrass. In 2003 we re-established grass-clover and ryegrass in all rotations for grazing in 2004. In 2005 grasslands similar managed during the last three years (2002-2004) but with widely different grassland frequency in the rotation are ploughed out. In these crop rotations during 1997-2004 grazed grassland has been present 2, 3 and 6 times equivalent to 25, 38 and 75% of the crop rotation. Thus, the long-term effect of composition and frequency of grasslands can be studied in a block design with four replicates.

Table 1: Crop rotations at the experimental area in Foulum for investigating residual effects of grassland. In brackets is indicated the proportion of grassland in the rotation during 1997-2004.

Year	Rotation 1 (25%)	Rotation 2 (38%)	Rotation 3 (75%)
1994	1st year grass	1st year grass	1st year grass
1995	2nd year grass	2nd year grass	2nd year grass
1996	3rd year grass	3rd year grass	3rd year grass
1997	Barley	Barley	4th year grass
1998	Wheat	Wheat	5th year grass
1999	Barley	Barley	6th year grass
2000	Barley	1st year grass	7th year grass
2001	1st year grass	2nd year grass	8th year grass
2002	Wheat	Wheat	Wheat
2003	Barley	Barley	Barley
2004	1st year grass	1st year grass	1st year grass
2005	Barley	Barley	Barley

In the spring 2005 the combinations of grassland composition (grass-clover and ryegrass) and frequency (25, 38 and 75% grassland) are ploughed and within each of the four replicates in the block design are established four plots of 12 by 12 m with barley. The barley has ryegrass undersown as a catch crop. To determine precrop effects of N an adjacent reference area without grassland history and with increasing mineral fertiliser N application is established for comparison of yields. To quantify other precrop effects than N and the yield potential for cereals following grassland, cattle slurry is applied to some of the grassland plots at ploughing. The same principles have been applied to the cereals in 2002 and 2003. In 2002 the pastures of grass-clover and ryegrass were ploughed after 1, 2 and 8 production years. As reference were used associated cut grassland and continuos cereal cropping. The yield in spring wheat was greatly increased by the grassland pre-crop (Fig. 1). 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 2003 the residual effect

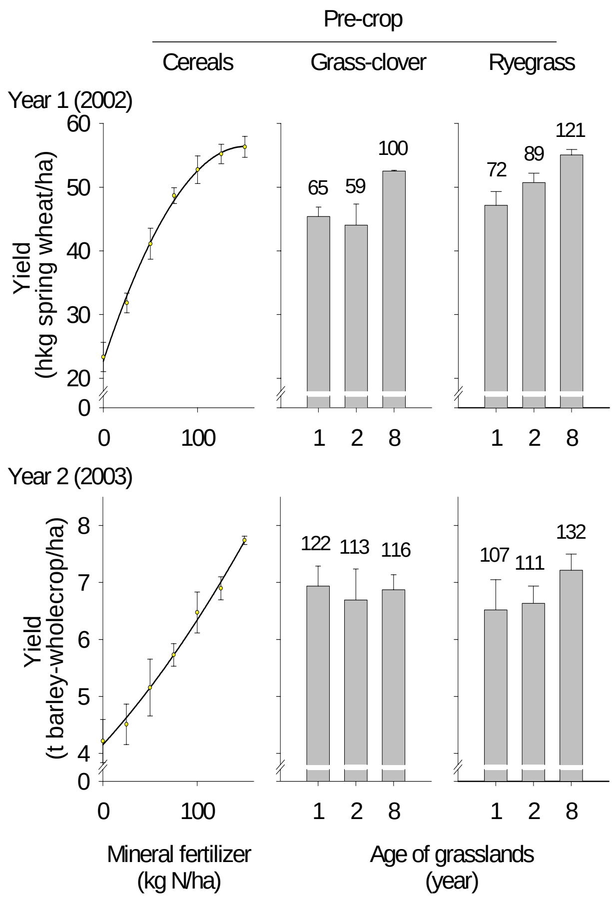

Fig. 1. Yield of spring wheat and barley-wholecrop in two years following ploughing of grasslands and compared to similar yields following a cereal history and with mineral fertiliser application. For cereals following grassland only unmanured plots are shown here. The number above the bar refers to the fertiliser replacement value of the grassland residual effect. Error bars: SE.

NB: Only 2003 data were funded by this project.

was even higher probably as a consequence of very low nitrate leaching in the winter 2002-2003, but this year differences between different grasslands seemed negligible.

In each of the 12 x 12 m plots are installed three ceramic suction cups at a depth of 1 m and 2 m apart, and every two weeks samples of soil water are collected by applying suction. The accumulated nitrate leaching is calculated after modelling the water balance. This method has been identified as the best practicable method for freely drained, structureless soils, which makes it suitable for this soil type. Nitrate leaching following the ploughing of grasslands was determined using the suction cup method in the winters 2002/2003 and 2003/2004 (Fig. 2). Due to low drainage in the first winter (234 mm), nitrate leaching was only moderate, but still differences appeared. Generally, 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). The results followed to some extent what would have been predicted by looking at the differences in pre-crop effect of the swards. It was striking that the EU Drinking Water Directive upper limit of 50 mg nitrate per litre was on average not exceeded in any of the plots where grass-clover was ploughed out but was exceeded in all plots where ryegrass had been grazed for more than 1 year. In this winter (2003-2004, drainage: 290 mm) the 50 mg nitrate per litre was on average not exceeded in any case (Fig. 2) although nitrate leaching following grazed ryegrass was higher than following grazed grass-clover. Overall the results indicate that when using good management practices following ploughing of grazed grassland it is possible to limit nitrate leaching losses to a minimum, especially in the case of grass-clover.

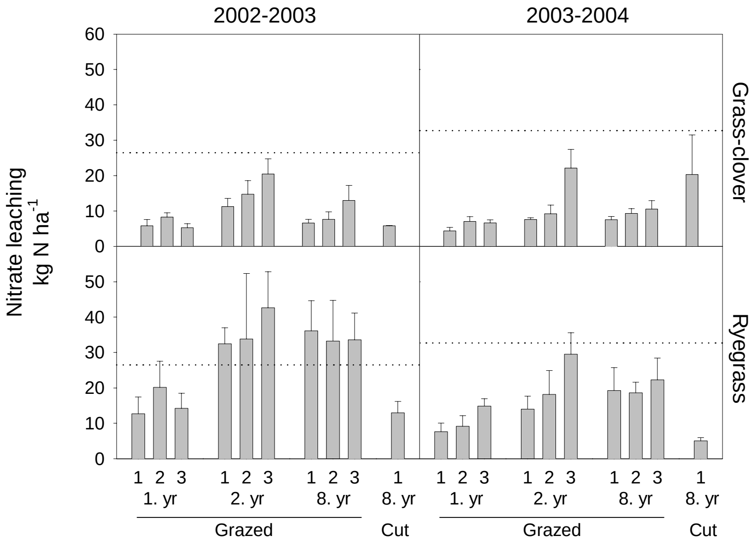

Fig. 2: Nitrate leaching in two years following ploughing of grasslands of different composition, age and management. Dotted lines indicate losses equivalent to the EU upper limit for nitrate content in drinking. Error bars: SE.

In the coming years nitrate leaching will be determined during grazing and following ploughing for the different combinations of grassland composition (grass-clover and ryegrass); frequency (25, 38 and 75% of crop rotation) and management following ploughing (4 levels of supplementary fertiliser).

WP2: Nitrate leaching on coarse sandy soils

On a dairy farm on coarse sandy soil were selected fields with different grassland history aiming at a minimum of bias caused by soil type and climatic conditions. The two fields were ploughed in spring 2003 and cropped with cereals in 2003 and 2004. The following factors are included in 2003. In 2004 are determined the residual effects.

Table 2: Treatments in the experiment on coarse sand.

Factor	Treatments
Accumulated N in grassland	1. 5-year-old pasture in grass-rich rotation 2. 3-year-old pasture in cereal-rich rotation
Establishment of catch crops	1. Spring barley with catch crop (Italian ryegrass) undersown – harvested green as fermented whole crop 2. Spring barley with catch crop (perennial ryegrass) undersown – harvested at maturity 3. Spring barley without catch crop – harvested at maturity
Fertilisation of barley following grassland	1. No fertiliser 2. Low fertiliser application (60 kg NH_4-N ha^{-1} in cattle slurry) 3. Moderate fertiliser application (120 kg NH_4-N ha^{-1} in cattle slurry)

In the experimental period is used best management practice regarding other factors that may influence N use efficiency. The experiment contains four replicates of each combination of treatments and 2 ceramic suction cups are installed in selected plots for determination of nitrate leaching. Suction cups are installed in all plots without fertiliser application and selected plots with fertiliser application. Nitrate leaching is determined in the two years from 1 April to 31 March with termination in 2005. Prior to ploughing of grasslands quantity and chemical composition of above- and below-ground plant material was determined. Yield and N-uptake of all crops are determined. From available data will be constructed N balances.

The effect of a perennial ryegrass catch crop on yield of spring barley harvested at maturity was insignificant for both grain and straw. However, grain yields showed a significant effect of N application after the 2-year-old pasture while no effect of N application was observed after the 5-year-old pasture. Increasing the N application from “Low” to “Moderate” tended to increase yield in the 2-year-old pasture but the increase was not significant. These facts imply that more readily available N was present after the 5-year-old than after the 2-year-old pasture. Yields of fermented whole crop increased with increasing N application on both fields, but the increase from “Low” to “Moderate” was not significant.

Table 3: Yield of barley and fermented whole crop following ploughing of 5-year-old and 2-year-old pastures. No significant interactions between Crop and N application was found.

	Barley		Fermented whole crop*1	
	Grain*2, hkg ha^{-1}	Straw dm, hkg ha^{-1}	Barley and grass dm*3, hkg ha^{-1}	1. cut of grass dm*4, hkg ha^{-1}
5-year-old pasture				
Crop				
Without catch crop	46.8	48.8	-	-
With catch crop	45.4	52.0	-	-
Early whole crop*2	-	-	-	-
$LSD_{.95}$	ns	ns	-	-
N application				
No	45.7	45.6^{b}	46.1^{b}	36.3
Low	47.5	49.2^{b}	61.0^{a}	41.9
Moderate	45.0	56.4^{a}	66.3^{a}	41.3
$LSD_{.95}$	ns	4.0	11.8	ns
3-year-old parsture				
Crop				
Without catch crop	44.4	35.1	-	-
With catch crop	44.0	35.5	-	-
Ferm. wholecrop*1	-	-	-	-
$LSD^{.95}$	ns	ns	-	-
N application				
No	39.7^{b}	25.7^{b}	28.8^{b}	26.1
Low	45.0^{a}	38.4^{a}	48.3^{a}	24.8
Moderate	48.0^{a}	41.8^{a}	57.5^{a}	31.4
$LSD_{.95}$	5.1	4.0	10.0	ns

Within each factor and column, means followed by the same letter are not significantly different from each other.

*1 Barley and grass harvested at beginning of heading

*2 85% dry matter. Harvested on 11 August 2003 at maturity

*3 Harvested on 17 June 2003

*4 Harvested on 15 August 2003

Table 4: Annual leaching of nitrate and organic N (kg N ha^{-1}) following ploughing-in of grass-clover and growth of spring barley with different catch crop situations. In brackets is shown the percentage of organic N compared to nitrate. Within each column, means followed by the same letter are not significantly different

	N-appl. kg/ha	After 3 years gr./cl.		After 5 years gr./cl.	
		Nitrate-N	Organic-N	Nitrate-N	Organic-N
Early whole crop - Ital. ryegr.	0	8 c	10 b (125)	35 b[1]	16 b (46)
Early whole crop - Ital. ryegr.	120	9 c	10 b (111)	7 b	12 b (171)
Barley maturity -per. ryegr.	0	34 c	10 b (29)	81 b	14 b (17)
Barley maturity - bare soil	0	174 b	13 b (7)	240 a	23 ab (10)
Barley maturity - bare soil	120	302 a	19 a (6)	316 a	29 a (9)

[1] This value was caused by one suction cup with extremely high concentrations. Excluding this cup the level is similar to that of other early whole crop treatments.

In Table 4 is shown nitrate and organic N leaching following spring barley. Annually, 174-240 kg NO_3-N and 13-23 kg organic N per ha was leached when unfertilised barley was harvested at maturity and followed by bare soil subject to mechanical weed control. In the same situation but with application of 120 kg NH_4-N to barley gave nitrate and organic N leaching of 166-309 and 19-29 kg/ha, respectively. A well-established Italian ryegrass following very early harvest of barley in mid-June reduced nitrate leaching by 166-309 kg N/ha or 95-98%. Perennial ryegrass following barley harvested at maturity was not as efficient as this, but still reduced nitrate leaching by 66-80% compared to ‘bare soil’. These results are very encouraging. It seems possible to reduce (almost eliminate) nitrate leaching following grassland ploughing even on course sand if efficient catch crops are established. It is also new that organic N is leached to this extent. Furthermore it is important to adjust fertiliser application to the actual need of the cereal crop – in many cases there is no yield response to fertiliser application following grassland ploughing.

WP3: SOAR Ph.D. study: Below ground C and N transformation processes in perennial grass-clover mixtures with impact on the farming system and the environment

The C and N dynamics in perennial grass-clover mixtures are not fully understood although such mixtures dominate temperate grassland. The co-existence of clover and grass involves both competition for and transfer of nutrients between the species. The nutrients may originate from leaky root systems, from a rapid turnover of the fine root systems, or from degradation of more stabile organic material. A better understanding of the processes involved in the C and N dynamics, especially the role of organically bound C and N, will form the basis for better modelling of grass-clover mixtures and thereby optimising the utilization of the nutrients which benefits both the farmer and the environment.

The aim of the study is to investigate the C and N dynamics in grass-clover mixtures with special attention to 1) the origin of DOC and DON in grass-clover mixtures, 2) the composition of DOC and DON from the species, and 3) the transfer of C and N between grass and clover.

The aim of the 2004 studies have been to investigate the origin of C and N from both grass and clover, to investigate the composition of C and N in a general sense by dividing it into inorganic and organic bound pools, and if possible to look for transfer of C and N between the two species.

In a second year grass-clover ley mezotrons were installed to depths of 20, 40 and 60 cm. Underneath the mezotrons suction cups were installed in order to collect porewater from the root zone. Grass or clover in the mezotrons was labelled using leaf labelling with ^{15}N- and ^{14}C urea. During the labelling period of 5 days and at regular intervals thereafter pore water from the root zone was collected. The canopy was harvested three times during the experimental period with an interval between harvesting of three weeks. At the end of the experimental period the mezotrons were excavated and divided into soil and plant compartments.

In order to model the water transport in the mezotrons bromide was added before the leaf labelling, and in order to have a surplus of pore water the mezotrons was irrigated at regular intervals.

Pore water samples were immediately analysed for total content of ^{14}C-labelled compounds. Still analysis of ^{15}N content of the pore water has to be undertaken together with measurements of inorganic parameters like pH and content of bromide. Also the analysis of ^{14}C and ^{15}N in soil and plant material has only been performed on very few samples at this point.

The preliminary results show that ^{14}C from both grass and clover can be found in the percolating pore water and the trends are that the amount of ^{14}C is higher from grass than clover. The leaching of ^{14}C was highest during the Labelling period and after the first harvest of the canopy where a pulse of ^{14}C was observed. The first results from the analysis of plant material show that both ^{14}C and ^{15}N are transferred between the species, but whether this is due to transfer in the root system or in the canopy has not been elucidated so far.

WP4: Optimising the N cycle of organic dairy farms

At the end of the project all the data that has been collected from the experimental area since establishment of the different grasslands in 1994 will be included in a summarising exercise. This includes N-uptake and nitrate leaching effects from the arable and grassland phase of the crop rotation caused by differences in grassland history, age and frequency – all of which has been combined with unfertilised grass-clover and fertilised ryegrass. Furthermore, N_2-fixation and denitrification has occasionally been determined as well as the N-balance of grazing cows. All this information will be used for constructing crop rotation N-balances and make simple scenarios for the effects of different crop combinations/frequencies. The effect of different management on the experimental area will be related to investigations from practical farms where the overall balance are known and to the results of the model exercises going on in other DARCOF projects. Such simple calculations based directly on experimental results are notoriously useful in the advice of farmers.

C.2 Fulfilment of deliverables and milestones
(To be completed for each work package)

WP number and title	Time schedule according to application	Deviations, if any*
Deliverables		
1 Paper on precrop effects of combinations of grass-clover/ryegrass and different frequencies of grassland in the rotation submitted for international reviewed journal.	Jan 2006	
2 Paper on nitrate leaching from different grassland rotations submitted for international reviewed journal.	May 2006	
3 Paper on nitrate leaching and management options on coarse sandy soils submitted for international reviewed journal	May 2006	
4 Ph.D. study on grassland nitrogen initiated.	July 2003	Dec 2003
5 Ph.D. study completed	July 2006	
6 Paper on nitrogen management in dairy farming systems published in farmers magazine.	Jan 2006	
7 Paper on environmental consequences of ploughing different grasslands published in farmers magazine.	May 2006	
Milestones		
1 The effect of soil type, grassland composition and frequency in crop rotations on precrop effects following ploughing has been determined.	Jan 2006	
2 The environmental consequences of grassland composition and frequency in the rotation has been determined.	May 2006	

** Deviations are to be further discussed in D*

D. Description of deviations and subsequent adjustments of plans

E. Project publications and other products

1. Products from Organic Eprints archive

Peer-reviewed and accepted

English

Eriksen, J.; Vinther, F.P. and Søegaard, K. (2004) Nitrate leaching and N2-fixation in grasslands of different composition, age and management. *Journal of Agricultural Science* 142:pp. 141-151.

Eriksen, J. and Askegaard, M. and Kristensen, K. (2004) Nitrate leaching from an organic dairy crop rotation: the effect of manure type, N-input and improved crop rotation. *Soil Use and Management* 20:48-54.*

Not peer-reviewed
English

Eriksen, J and Vinther, FP (2004) Nitrate leaching and N2-fixation in grasslands of different composition, age and management. Paper presented at 12th N Workshop; Published in Hatch, DJ and Chadwick, DR and Jarvis, SC and Roker, JA, Eds. *Controlling nitrogen flows and losses*, page 434-436. Wageningen Academic Publishers, The Netherlands.
Eriksen, J. and Vinther, F.P. (2003) Nitrate leaching and N2-fixation in grasslands of different composition, age and management. Poster presented at 12th N workshop "Controlling N Flows and Losses", University of Exeter, Devon, UK, 21st - 24th September, 2003; Published in *Abstracts for the 12th N workshop "Controlling N Flows and Losses"*.
Rasmussen, Jim and Høgh-Jensen, Henning (2004) Origin and composition of Dissolved Organic C and N from grass-clover mixtures. Poster presented at Cost Action 627 - Carbon Storage in European grasslands, Ghent, Belgium, June 3-6 2004.[*]
Vinther, F. P. and Eriksen, J. and Hansen, E.M. (2004) Leaching of dissolved organic carbon (DOC) and nitrogen (DON) from grass-clover pastures after ploughing.. [oral] Presentation at *DOM 2004 - International workshop: Dissolved Organic Matter and the Cycling of Carbon, Nutrients and Metals*, Bayreuth, Germany, October 3-6 2004.
Eriksen, J (April 2004) Efficient use of grassland nitrogen. Online at <http://www.darcof.dk/enews/april04/grassland.html>. Newsletter from Danish Research Centre for Organic Farming
Dansk - Danish
Eriksen, J (2004) Udvaskning før og efter ompløjning af kløvergræs. In *Månedsmagasinet Mark*, January, Volume 1, page 18.
Eriksen, J. (2003) Afgræsningsmarkers eftervirkning [Residual effect of grasslands]. In *Økologisk Jordbrug*, No 283, page 6.
Eriksen, J (April 2003) Afgræsningsmarkers eftervirkning. Online at <http://www.foejo.dk/enyt2/april03/efterv.html>. Nyhedsbrev fra Forskningscenter for Økologisk Jordbrug

2. Other products (oral presentations, public meetings, field days, etc.)

Jørgen Eriksen and Margrethe Askegaard presented a poster on "Nitrogen management in the organic dairy crop rotation" at the organic field day in Foulum, June 12, 2003.
Jørgen Eriksen and Margrethe Askegaard presented an organic field experiment with grassland and maize at the organic field day in Foulum, June 10, 2004.
Jørgen Eriksen gave a presentation on "The effect of catch crops on the supply of N and S in organic crop rotations" at the Organic field course in Årslev on June 19, 2003.

* 25-75% financed by DARCOF
** 5-25% financed by DARCOF

F. Scientific education

The project includes part of a Ph.D. study for Jim Rasmussen starting primo 2004 and a Master student have been associated from February 2003 to February 2004: Jens Prior Hansen M.Sc. project: Residual effect of ploughing out grasslands as a function of grassland age, management and fertilisation.

G. National and international cooperation

The project has a life of its own, but it is also an integrated part of other activities in the DARCOF programme and in international programmes. This includes:

- DARCOF project VII.12 will intensively be using the experimental area for detailed studies on leaching of dissolved organic carbon, denitrification and simulation using the DAISY model. The two projects will work in close collaboration experimentally and in the interpretation of data (Contact: Ole H. Jacobsen, DIAS).
- DARCOF project VII.16 will be using the experimental area in communication of results from organic farming research to practical farming (Contact: Jørgen E. Olesen, DIAS).
- DARCOF project I.4 uses the area in research for increased quality of wheat for breadmaking (Contact: Bent T. Christensen, DIAS).
- DARCOF project I.13 uses the area for determination of N_2-fixation of grass-clover and denitrification from grazed grassland (Contact: Per Ambus, RISØ).
- DARCOF project I.3 will be using data from the experimental area for modelling N cycling in organic farming systems (Contact: Jørgen E. Olesen, DIAS).
- The EU-project “Greenhouse Gas Mitigation for Organic and Conventional Dairy Production (MIDAIR)” will be using the two grassland types present in a block design on the area (Contact: Søren O. Petersen, DIAS).
- The project leader and project staff are involved in collaboration with a range of European partners through the EU-COST-action 627 “Carbon Storage in European Grasslands” and 852 “Exploiting the Agronomic Potential of Forage Legumes in Contrasting Environments of Europe”.

The results from other projects are continuously being exchanged and this synergy of more projects and many results from the same system improves the opportunity of reaching the objectives of the present project.

H. Critical reflection on the project

Results from different projects within the DARCOF framework indicated that nitrate leaching on coarse sandy soils might constitute a substantial problem. Although the NIMAB project showed that nitrate leaching following the ploughing of grassland could be controlled on sandy loam soil, the EX_UNIT project and measurements on private farms in the BIO_MOD project indicated large losses on coarse sandy soils. Keeping in mind that a major part of organic dairy farming is located on coarse sandy soils, the previous experimental work within DARCOF may not have been representative. Therefore, at this stage it is not clear whether the recommended management following grassland ploughing is sufficient to avoid large leaching losses from these soils. In order to overcome this, a supplementary experiment was initiated on coarse sandy soil (WP2) and a Ph.D. study is associated with this. It is our expectation, that this expansion of the NIT_GRASS project will provide a better possibility for generalising results from the DARCOF projects.

In WP2 the suction cups were installed at 100 cm depth in spring 2003. During the following winter the ground water table rose to less than 100 cm and therefore we re-installed the cups at 70 cm depth in December. To check if rising the suction cups to 70 cm missed a peak of nitrate, extra cups were installed at 40 and 100 cm in two treatments. On the basis of this it was clear that for the low-nitrate-concentration treatments this was certainly not the case and for the high-nitrate-concentration treatments this may have caused a slight underestimation of annual nitrate leaching. So on the basis of this we feel confident that sound conclusions can be made based on the dramatic treatment differences observed.

Recently, it has been reported, especially in the UK, that leaching may not only be restricted to nitrate in grasslands but also some dissolved organic nitrogen has been found in leachates. Whether this is relevant to lighter soils under Danish conditions may be questioned but to get some indication extra measurements of dissolved organic N has been carried out in leachates from the coarse sand and has to some extent confirmed quantitative leaching of organic N.

We have experienced that the, for the reductions of nitrate leaching, successful catch crop strategy has a down side at some sites: The development of weed problems, especially with thistle. Although some weed control has been carried out between sowing of cereal and sowing of catch crops in the cereals, this may not always be efficient. We will consider before the ploughing out of grassland in WP1 in 2005 to use more severe weed control, such as sowing at double distance and hoeing. As this may affect negatively the tightness of the N cycle it must be considered if this can be investigated experimentally.

8. Budget

A. Account for any change in budgets

B. Budget for the whole project (1.000 DKK)

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

Year:	Consumption before 2004	Expected consump-tion 2004	2005	2006	Total
Man-months	6.75	15.75	15	4	41,5
Scientific personnel	1.25	10.75	8	2	22
Technical personnel	5.5	5	7	2	19.5

Year:	Consumption before 2004	Expected consump-tion 2004	2005	2006	Total
Salaries	217	614	634	173	1,638
Scientific personnel	61	460	406	104	1,032
Technical personnel	156	153	228	69	606
Other operational costs	22	201	101	29	680
Equipment					
Others (please specify)					
Direct costs	239	815	735	202	1,991
Indirect costs (20% of direct costs)	47	164	147	41	399
Total	286	979	882	243	2,390

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Jørgen Eriksen	Danish Institute of Agricultural Sciences		

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

NIT_GRASS Danish Institute of Agricultural Sciences

Year:	Consump-tion before 2004	Expected con-sumption 2004	2005	2006	Total
Man-months	6.75	11.25	15	4	37
Scientific personnel	1.25	6.25	8	2	17.5
Technical personnel	5.5	5	7	2	19.5

Year:	Consump-tion before 2004	Expected con-sumption 2004	2005	2006	Total
Salaries	217	479	634	173	1,503
Scientific personnel	61	326	406	104	897
Technical personnel	156	153	228	69	606
Other operational costs	22	169	101	29	648
Equipment					
Others (please specify)					
Direct costs	239	648	735	202	1,824
Indirect costs (20% of direct costs)	47	131	147	41	366
Total	286	779	882	243	2,190

Comments: Two scientific man-months and 93,000 kr in operational costs have been moved from 2003 to 2004.
Two technical man-month have been moved from 2004 to 2005.

A. Budget for each participating institute (1.000 DKr)

NIT_GRASS Royal Veterinary and Agricultural University

Year:	Consumption before 2004	Expected consump-tion 2004	2005	2006	Total
Man-months		4.5			
Scientific personnel		4.5			
Technical personnel					

Year:	Consumption before 2004	Expected consump-tion 2004	2005	2006	Total
Salaries		135			
Scientific personnel		135			
Technical personnel					
Other operational costs		32			
Equipment					
Others (please specify)					
Direct costs		167			
Indirect costs (20% of direct costs)		33			
Total		200			200

Comments: This project only in part funds the Ph.D. study and is therefore used in 2004.