



Annual Status Report 2001 and Application for Continuation in 2002

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The Directorate for Food, Fisheries and Agro Business
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1. Research program

Research in organic farming 2000-2005 (DARCOF II)

2. Project title and number

I.4 Nitrogen Management and cropping methods for enhanced Bread wheat production
(NIMAB)

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7. **Start of project:** 2000
End of project: 2004

8. Annual report/Application for continuation in 2002

A. Objectives and expected achievements (from application)

The overall aim of the project is to improve the N management and cropping methods in organic plant production in order to enhance the quality and quantity of homegrown bread wheat. This is done by improving the crop N-use efficiency in organic crop production and reducing the leaching loss of nitrate from the soil/plant system. The objectives and expected achievements of the work included in this project are specified below.

Utilization of N in grazed grass/clover pastures

The objectives are to reduce the loss of nitrate by leaching from grazed grass/clover pasture, to establish the importance of pasture age for N utilization in subsequent crops, and to examine the potential for production of high quality wheat combining precrop effects of grazed grass/clover and dressings of organic manures.

The expected achievements include an improved N utilization on grass intensive dairy farms, a reduced leaching loss of nitrate following termination of grazed grass/clover pastures, and an increased production of high quality wheat for breadmaking.

Soil tillage strategy and organic matter management for improved N-use efficiency

The objectives are to quantify the potential of soil tillage in regulating soil N turnover during the growth of cereal crops, and to determine the interactions between tillage induced effects on N mineralization and organic matter management. The strategic aim is to improve the synchrony between soil N mineralization rates and N uptake in wheat intended for human consumption.

The expected achievements are to develop tillage strategies that improve the N economy of cereal production on soils with different organic matter management and fertility status.

Crop and weed competition and N uptakes as affected by manure placement

The objectives are to enhance cereal crop uptake and reduce weed accessibility of N in banded animal slurry dressings by adjusting the slurry placement geometry, and to improve the competitive ability of cereals towards weeds by choice of crop variety and manure application method.

The expected achievements are recommendations for slurry application strategies that will improve exploitation of the N resource in manure and the control of weeds in cereal cropping systems.

Bread wheat quality as affected by crop variety and N management

Main objectives are to identify crop varieties suitable for organic bread wheat production under Danish growth conditions, to adapt and implement rapid NIT-based methods to test for breadmaking grain quality, to establish suitable quality standards for organically produced bread wheat and to contribute to the clarification of interactions between baking quality, crop variety and N management.

The expected achievements include better test methods and quality standards to be used by farmers, trading and milling industry, and recommendations on choice of crop variety and management for increased production of organically grown wheat for bread purposes.

B. Project summary (from application)

The demand for organically produced grain for bread considerably exceeds Danish farmers' production. Thus, nearly 70% of the consumed organically grown bread wheat is imported. The overall objective of the proposed project is to improve the N management and cropping methods in organic plant production in order to enhance the quality and quantity of homegrown bread wheat while improving the crop N-use efficiency and reducing the leaching loss of nitrate from the soil/plant system.

The four work-packages (WP) contribute to the overall objective by focusing on how N accumulated in grazed pastures can efficiently be used for production of bread wheat without excessive nitrate leaching (WP1), on how soil tillage can be implemented for regulating soil N turnover during growth of cereal crops in order to improve the synchrony between soil N mineralization rates and N-uptake (WP2), on how manure placement can enhance cereal crop uptake and increase the competitive ability towards weeds (WP3) and on how the crop variety, N management and baking quality interact (WP4).

The studies draw on a spectrum of cropping systems, soil types and N managements, combining field experimentation and laboratory studies.

Table 1: Work package list

Work-package No	Work package title	Responsible participant	Budget (1000 DKK)	Start	End	Deliverable No
WP1	Utilization of N in grazed grass/clover pastures	JE	1446	2001	2004	13, 21, 26, 27
WP2	Soil tillage strategy and organic matter management for improved N use efficiency	IKT	1864	2000	2004	6, 10, 20, 22, 25
WP3	Crop and weed competition and N uptake as affected by manure placement	JP	1106	2000	2003	3, 7, 11, 12, 17, 18
WP4	Bread wheat quality as affected by crop variety and N management	JRJ	2154	2000	2004	14, 15, 23, 24

C. Progress

C.1 Annual description (resume) of main results and conclusions

WP1: Utilization of N in grazed grass/clover pastures

The organic grass/clover experiment (GCE, see EXUNIT for further details) at Research Centre Foulum includes four different grassland histories (grazed and cut grass/clover, grazed and cut pure grass). The original grassland histories were established in 1993 and a part was ploughed in 1997 resulting in associated plots of cultivated land and older pastures. Each plot is equipped with three ceramic suction cups for collection of soil water leaching from the root zone. Nitrate leaching is estimated from nitrate concentrations in percolation and the drainage volume. The work in this WP consists of three activities:

Activity 1: Nitrate leaching from older pastures

Using the suction cup technique nitrate leaching is determined throughout the autumn and winter period by collecting samples of soil water below the root zone weekly or biweekly from grazed (with dairy cows) and cut fields (unfertilized grass/clover and fertilized pure grass). In 2000 one half of each grassland history that was cultivated in 1997 was reseeded to grass, the other half being reseeded in 2001. Thus, 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 will be possible to compare 1st, 2nd and 8th year pasture allowing for estimates of the effect of increasing N accumulation in grassland on nitrate leaching.

In the newly established swards nitrate leaching from grass-clover and ryegrass were similar but at increasing sward age nitrate leaching from the fertilized ryegrass increased dramatically compared to a constant low level from the unfertilized grass-clover (fig. 1). Apparently, the clover component of grass-clover was able to equalize differences in soil nitrogen availability in swards of different age. The results of N₂ fixation studies in swards of different age in 2001 will be used in the interpretation of the nitrate leaching data.

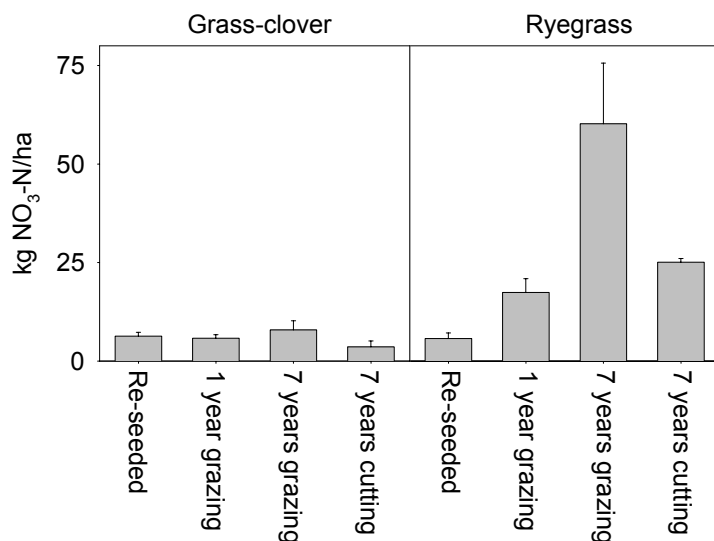


Figure 1. Nitrate leaching from grassland of different age.

Activity 2: Ploughing grazed pasture with different age

No activity planned for 2001.

Activity 3: Fertilizer strategy for production of high quality spring wheat after pastures

No activity planned for 2001.

WP2: Soil tillage strategy and organic matter management for improved N use efficiency

Activity 4: Organic matter levels and tillage frequency

This activity was based on The Spring Cereal Rotation of the Systems Research Areas at Foulumgaard (Rasmussen & Hansen, 1994). The rotation was established in 1987 and includes different organic matter management strategies: 1 = no additional organic inputs, 2 = nitrate catch crop + animal slurry, 3 = straw + animal slurry, and 4 = nitrate catch crop + straw + animal slurry. Over the years, these strategies have accumulated different levels of soil organic matter.

It was intended to grow spring wheat in the experiment in 2001. However, we were informed by the field experiment manager that the risk of infection of the wheat with the take-all fungus (*Gaeumannomyces graminis*) was very high. It was therefore decided that the experiment should be carried out with spring barley in 2001.

The barley was sown in April at double row spacing (25 cm). Each plot was subdivided into four smaller plots. One of these smaller plots was left undisturbed during the active growth phase. The remaining three plots were exposed to soil disturbance either one (16 May), two (16 May, 30 May) or three (16 May, 30 May, 13 June) times during the growing season. The soil disturbance was carried out with a row rotovator to 8 cm soil depth. Soil samples and plant cuts were taken in the undisturbed and disturbed plots immediately before the soil disturbance and one, two and three weeks after the disturbance.

The soil samples are analysed for inorganic N content. The plant biomass from the cuts and from harvest at maturity are analysed for N content. Grain samples will be analysed as described for activity 13.

Activity 5. Nutrient regime, preplant tillage and crop N uptake pattern

The Askov Long-Term Experiments on Animal Manure and Mineral Fertilizers were initiated in 1894 (Christensen et al., 1994). In 1996, one of the four blocks at Lermarken (B4-field) was converted to an organic farming workshop area now comparing equivalent dressings of N, P and K given either in cattle slurry or in farmyard manure. Three nutrient levels are compared with unmanured treatments. Consult EXUNIT (ASK) for further details.

The B4 block at Lermarken grew grass-clover in 2000. In spring 2001 two tillage intensities were applied to each plot before sowing. One half of the plot was ploughed directly. The other half was rotovated intensively before ploughing. All plots were subsequently sown to spring wheat. Nine times following germination of the spring wheat, soil was sampled from selected plots for determination of mineral N content. Plant biomass was collected from the same plots and analysed for total N content. At the same dates, a hand held remote sensor was used to measure the spectral reflectance at all plots. The spring wheat was harvested at maturity and analysed for total N content in grain and straw. Grain samples from selected treatments are submitted for analyses of baking quality (WP4).

Activity 6: N mineralization rate as affected by intensity of soil disturbance

No activity planned for 2001.

Activity 7: Mechanisms that control the retention and mineralization of labile organic N

No activity planned for 2001.

WP3: Crop and weed competition and N uptake as affected by manure placement

Activity 8: Recovery of ¹⁵N in crop and weeds

No experimental activity planned for 2001. Agreements concerning experimental site are committed, and technical agreements are in elaboration.

Activity 9: Initial growth of roots

Root growth experiments have been carried out in November and December 2000. Nine spring wheat varieties, 2 oat varieties, 1 barley variety and 10 weed species were grown for 14 (one week after emergence), 17, 21 and 24 days in plastic tubes (diameter: 56mm – high: 330mm.). After 24 days the roots of the cereals were almost at the bottom of the tubes. The climate was simulating average climate in Denmark medio April. Germination speed and percentage, root and top length and weight

were measured and roots were scanned for further picture analysis'(Figure 2). From the picture analysis a lot of data are available (examples in Table 1) including fractions of different root sizes. At the tested conditions the root growth of the cereals was superior to the weeds. Small differences between the wheat varieties were seen compared to other cereals and the weeds. In general barley had a faster root development than spring wheat and the spring wheat was faster than the oat and the weeds. These results confirm the hypothesis that cereals reach nutrients placed within a certain distance from the germination site before weeds.



Figure 2. Scannings of roots from the wheat variety 'Leguan' 14, 17 21 an 24 days after sowing.

Table 1. Selected preliminary data from selected varieties and species 24 days after sowing

Measurements	Wheat Leguan	Wheat Dragon	Wheat Melon	Wheat 'Land'	Barley Alexis	Oat Rise	<i>Avena futua</i>	<i>Sinapis Arvensis</i>
Seed weight (mg)	40.7	41.4	51.6	42.1	46.0	21.3	15.3	2.9
Germ. Pct. (24 days)	100	97	96	98	98	93	76	37
Germ. Pct. (7 days)	67	88	40	95	96	3	0	6
Top weight (mg)	17.9	5.3	12.1	19.2	17.3	10.1	6.3	6.2
Root weight (mg)	9.8 *	9.2*	10.9 *	-	-	-	-	1.8
Root length (cm)	116	100	82	110	140	58	32	34
Root Volume (cm ³)	0.26	0.23	0.24	0.30	0.44	0.22	0.16	0.07
Root tips	56.4	56.4	38.2	54.6	72.0	63.6	44.2	38.6
Root forks	94.8	101.4	47.2	91.4	97.0	82.6	65.6	90

* 21 days after sowing

Activity 10: Competition between spring wheat and weeds.

Based on the root experiments and availability on the market the varieties 'Leguan' and 'Dragon' was selected for the field competition experiment. As a competitive 'weed' specie was chosen *Lolium multiflorum* as an artificial competitor. The original intention to use green manure as a reference was not possible due to poor establishment of the catch crop - oil seed rape. As an alternative injection of liquid manure before and after ploughing was compared to surface applied liquid manure before ploughing. The split plot design with 4 replications is shown in Table 2 with some preliminary results.

Table 2 Preliminary data from filed experiment. Densities and biomasses were measured the 18th of July.

Factor	Germ. After 14 days	Wheat biomass (g/m ²)	<i>Lolium</i> biomass (g/m ²)	Nat. weed Biomass (g/m ²)	<i>Lolium</i> density (ears/m ²)	Nat. weed Density (pl./m ²)
1. Nutrient application (main plot)						
a. Surface b.f. plough.	418b	944a	59a	33a	102b	65a
b. Inject b.f. plough.	419b	975a	52a	31a	90a	60a
c. Inject a. plough.	326a	948a	75b	40a	110b	63a
2. Wheat variety (main plot)						
d. Leguan	358a	945a	68b	37a	111b	63a
e. Dragon	417b	966a	56a	32a	91a	62a
3. Weed density (subplot)						
f. 0 <i>Lolium</i> m ⁻²	-	1063a	0 -	47a	0 -	72a
g. 50 <i>Lolium</i> m ⁻²	-	991b	12 -	48a	20 -	66a
h. 150 <i>Lolium</i> m ⁻²	-	998ab	33 -	45a	47 -	63a
i. 450 <i>Lolium</i> m ⁻²	-	920c	73 -	41ab	110 -	62a
j. 1000 <i>Lolium</i> m ⁻²	-	804d	190 -	30b	326 -	51b
Interactions		1*3	1*3, 2*3		1*2*3	

The preliminary data analysis (ANOVA) indicate that injection of liquid manure before ploughing is the best application method regarding the crop weed interactions. Wheat biomass is high and weed biomass is low. Injection after ploughing seems to influence germination of the crop and to stimulate weed growth. Of the two wheat varieties Dragon tend to be the most competitive, which is a contradiction to the root growth analysis. One reason could be its longer straw, which provide a higher above ground competition for light. Another reason could be interactions, which is not yet estimated. Further non-linear regression analysis will be conducted to estimate the influence of manure application methods and wheat varieties on the crop-weed interactions. Furthermore crop and *Lolium* samples have been collected for analysis of nutrient content two times and spectral reflectance measurements have been conducted 11 times during the growth season.

Yield data is not yet available. Unfortunately the harvest was disrupted by rain. The first block was harvested the 1st of September but wet conditions forced us to stop. Afterwards an unusual long period of rain and wet conditions prevented further harvesting until the 26th of September. Consequently the quality have decreased and the deliverables of grain samples (D3) for breadmaking quality analysis might be concentrated on the samples from the first harvest time (block 1).

WP4: Bread wheat quality as affected by crop variety and N management

Activity 11: Field Trial Pajbjergfonden

The Danish plant breeding company "Pajbjergfonden" supplies the project with organic grown winter wheat varieties. In late 1999 Pajbjergfonden initiated a project on "Plant breeding in relation to organic farming" In the project 48 winter wheat varieties are tested in 4 replicated organic grown field trials. Two of these are without animal manure, one is fertilised with pig-slurry and one is fertilised with cattle-slurry. The field trials are repeated in year 2001 and 2002. The purpose of the project is to identify well-adapted high yielding wheat varieties for organic farming. Approximately 20 of these varieties are also tested in conventional field trials. Grain samples are delivered to laboratory analysis (Activity 13 and 14)

- In 2000, 920 wheat grain samples were collected (26 cultivars), in addition 800 barley samples were collected.
- In 2001, 900 wheat grain samples were collected, in addition 800 barley samples are to be collected.

Activity 12: Field trial Research Centre Flakkebjerg

In the organic crop rotation area at Research Centre Flakkebjerg (FL1, EXUNIT) a field trial was established to examine the competition and synergetic relations between winter bread wheat and

green manure. The field trial will be repeated in year 2001 and 2002. Grain samples are delivered to laboratory analysis at DIAS-PB and DIAS-FVFS.

Activity 13: NIT and image analysis

The grain analyses focus on qualitative traits of grains. These are measured preliminarily by Near Infrared Transmission (NIT) and image analysis. Development of calibration for NIT scanning allows analysis of wheat grains for content of protein, starch, gluten, water and zeleny number. Image analysis may be used for rapid determination of 1000 kernel weight, kernel shape and colour. Furthermore specific weight will be measured. Possibly development of new NIT calibrations will be attempted based on the flour analysis. Grain samples from Activity 11 and 12 and WP1-WP3 will be included.

- In 2000/2001, 920 wheat grain samples were analysed for content of protein, starch, gluten, water, zeleny, and test weight. In addition, approximately 800 barley samples were analysed for protein, starch, water and test weight from activity 11.
- Grain samples were analysed for protein, starch, water, gluten, zeleny, and test weight from activity 12 (harvest 2000 and 2001) and from WP1.
- An Access database for results and NIR scans is under development.

Activity 14: Flour analysis and baking characteristics

Flour analysis focus on content of protein, gluten and starch. Furthermore flour yield and particle size distribution are determined. The elasticity and extensibility of the gluten structure and the ability of the starch to gelatinise are characterised by rheological measurements. Baking characteristics are examined using selected samples in collaboration with the milling company "Drabæks Mølle". Grain samples from Activity 12 and WP1-WP3 will be included.

- From the field trial at Pajbjergfonden (activity 11, harvest 2000), 12 varieties were selected, with the purpose to characterise the baking potential. Grain samples from four organic and one conventional field trial were milled on a laboratory mill, and protein and gluten content was determined. Levels of protein and gluten seemed to be low for nearly all samples.
- Spring wheat samples (harvest 99) from grazed grass/clover pastures were analysed with the aim to compare baking potential of wheat from fields with different levels of grazing and N-addition. Analysis included protein and gluten content. on flour.

Rheological characterisation of flour from grain samples, Pajbjergfonden 2000, will be finished at the beginning of 2002. This deviation from time schedule is due to technical problems.

C.2 Fulfilment of tasks and deadlines in individual work packages

(To be completed for each work package)

WP0 Common part of the NIMAB project	Time schedule according to application	Deviations, if any*
Deliverables		
D1 Timetable, version 2	Nov2000	✓
D2 1 st status report	Nov2000	✓
D4 Timetable, version 3	Nov2001	
D5 2 nd status report	Oct2001	✓
D8 Timetable, version 4	Nov2002	
D9 3 rd status report	Nov2002	
D16 Timetable, version 5	Nov2003	
D19 4 th status report	Nov2003	
D28 Final status report	Nov2004	

* Deviations are to be further discussed at C3

WP1 Utilization of N in grazed grass/clover pastures	Time schedule according to application	Deviations, if any*
Task/Activity		
1 Nitrate leaching from older pastures	Jan2001-Jun2002	
2 Ploughing grazed pastures with different age	Apr2002-Sep2004	
3 Fertilizer strategy for production of high quality spring wheat after pastures	Apr2002-Jun2004	
Deliverables		
D13 Grain samples for breadmaking quality analysis	Dec2002	
D21 Paper on nitrate leaching from pastures submitted	Dec2003	
D26 Paper on N-utilization when ploughing pastures submitted	Oct2004	
D27 paper on good management practices when ploughing pastures submitted	Oct2004	
Milestones		
M1 The effect of pasture age on nitrate leaching has been analyzed and results submitted	Dec2003	
M2 The efficiency of precrop effect for production of spring wheat of breadmaking quality has been determined and results submitted	Oct2004	

* *Deviations are to be further discussed at C3*

WP2 Soil tillage strategy and organic matter management for improved N-use efficiency	Time schedule according to application	Deviations, if any*
Task/Activity		
4 Organic matter levels and tillage frequency	Mar2001-Nov2001	✓
5 Nutrient regime, preplant tillage and crop N uptake pattern	Aug2000-Nov2001	✓
6 N mineralization rate as affected by intensity of soil disturbance	Mar-Nov2002 Mar-Nov2003	
7 Mechanisms that control the retention and mineralization of labile organic N	May-Sep 2002 May-Sep 2003	
Deliverables		
D6 Grain samples for breadmaking quality analysis	Oct2001	✓
D10 Grain samples for breadmaking quality analysis	Nov2002	
D20 Grain samples for breadmaking quality analysis	Nov2003	
D22 Paper on synchronizing N utilization by time and intensity of tillage submitted	Jan2004	
D25 Paper on N turnover as affected by soil disturbance submitted	Jul2004	
Milestones		
M3 Strategies for improving N-use efficiency in production of wheat of breadmaking quality have been investigated and results submitted	Jan2004	
M4 Studies of mechanisms that control the retention and mineralization of labile organic N have been carried out and results submitted	Jun2004	

* *Deviations are to be further discussed at C3*

WP3 Crop and weed competition and N uptake as affected by manure placement	Time schedule according to application	Deviations, if any*
Task/Activity		
8 recovery of 15N in crop and weeds	Mar2002-Oct2003	
9 Initial growth of roots	Aug2000-Jan2001	✓
10 Competition between spring wheat and weeds	Mar2001-Nov2002	

Deliverables		
D3 Grain samples for breadmaking quality analysis	Oct2001	On time, but only samples from one replicate due to bad weather conditions at harvest
D7 Grain samples for breadmaking quality analysis	Oct2002	
D11 Paper on initial root growth and competitive ability of cultivars as influenced by nutrient source and application method submitted	Nov2002	
D12 Leaflet on weed control in high quality spring wheat	Nov2002	
D17 Paper on 15N uptake in crop and weeds as affected by placement submitted	Nov2003	
D18 Leaflet on N uptake in crop and weeds as affected by placement submitted	Nov2003	
Milestones		
M5 The effects of placement geometry of 15N-recovery in spring wheat and weeds have been analyzed and results submitted	Nov2003	
M6 Results on initial root growth and on crop/weed competition have been analyzed and submitted	Nov2002	

* Deviations are to be further discussed at C3

WP4 Bread wheat quality as affected by crop variety and N management	Time schedule according to application	Deviations, if any*
Task/Activity		
11 Field trial Pajbjergfonden	Aug2000-Sep2002	✓
12 Field trial Research Centre Flakkebjerg	Aug2000-Sep2002	✓
13 NIT and image analysis	Oct2001-Mar2002 Oct2002-Mar2003 Oct2003-Mar2004	
14 Flour analysis and baking characteristics	Oct2001-Mar2002 Oct2002-Mar2003 Oct2003-Mar2004	
Deliverables		
D14 Paper on recommendations on choice of variety of organically grown winter wheat for breadmaking	Mar2003	
D15 Paper on competition and synergetic relations between winter bread wheat and green manure	Sep2003	
D23 Paper on suitable quality standards for organically produced bread wheat	Jun2004	
D24 paper on development of rapid non-destructive spectral quality analysis	Jun2004	
Milestones		
M7 Quality of organically grown winter wheat varieties analyzed and results submitted	Mar2003	
M8 Competition and synergetic relations between winter bread wheat have been studied and results submitted	Sep2003	
M9 Conclusions on studies of gluten structure and breadmaking properties. Results submitted	Jun2004	

* Deviations are to be further discussed at C3

C.3 Discussion on the progress, incl. deviations and achievements in the project as a whole and in the individual work packages

The NIMAB project was initiated on 1 August 2000 and project meetings have been held on 30 October 2000 and 30 May 2001 to confirm timetables and update coordination of activities. Experimental activities were initiated primo 2001 according to plans. Progress in preparations and plan adjustments in the various ongoing field experiments to be used in the project is developing according to activity plans, and only minor adjustments have been introduced.

D. Description of plans and future work in the project as a whole and in the work package (Including plans for publication and communication)

WP1: Utilization of N in grazed grass/clover pastures

Activity 1: Nitrate leaching from older pastures

Using the suction cup technique nitrate leaching is determined throughout the autumn and winter period by collecting samples of soil water below the root zone weekly or biweekly from grazed (with dairy cows) and cut fields (unfertilized grass/clover and fertilized pure grass). In the winter 2001-2002 it will be possible to compare 1st, 2nd and 8th year pasture allowing for estimates of the effect of increasing N accumulation in grassland on nitrate leaching.

Activity 2: Ploughing grazed pastures with different age

The plots in activity 1, where grassland histories of different age have been established, are used for determination of precrop effects. In 2002 are ploughed pastures 1, 2 and 8 years old. As a reference is used the associated cut grassland. Nitrate leaching is determined before and after ploughing the pastures, and in the following years using the suction cup technique as described above. The N uptake is determined in spring wheat after ploughing. The precrop effect from the combinations of pasture use and pasture age is determined from the yield of spring wheat compared to the yield of an adjacent area without grassland history, which is used as a nil precrop reference.

Activity 3: Fertilizer strategy for production of high quality spring wheat after pastures

The precrop effects determined in activity 2 may in some cases not be sufficient to produce spring wheat of breadmaking quality. Therefore different strategies for supplementary cattle slurry application is investigated. The slurry application strategies differ in quantity and time of application. For all combinations of precrop effect and supplementary slurry application is determined leaching losses in the following autumn and winter using ceramic suction cups and plant uptake. The quality for breadmaking purposes is evaluated in cooperation with WP4.

WP2: Soil tillage strategy and organic matter management for improved N-use efficiency

Activity 4: Organic matter levels and tillage frequency

The field experimental activity has been completed at harvest 2001. The remaining work includes chemical analyses of soil and plant materials, data processing, and reporting. Part of this work is incorporated into WP4, Activities 13 and 14. An interim report on data achieved in Activity 4 is planned for 2002.

Activity 5: Nutrient regime, preplant tillage and crop N uptake pattern

The completion of this activity awaits chemical analyses and data processing of results obtained in the field experiment. These results will be incorporated in an interim report due in 2002. Final reporting from Activity 5 is postponed until analyses of samples in WP4, Activity 13 and 14 are completed.

Activity 6: N mineralization rate as affected by intensity of soil disturbance

The activity is based on The Spring Cereal Rotation of the Systems Research Areas at Foulumgaard using the same organic matter management strategies as in Activity 4 but with winter wheat. Two tillage intensities are tested in winter wheat grown at double row spacing (25 cm) using implements that accomplish different intensity of soil disturbance (a conventional row crop cultivator and a PTO-driven row rotavator). A reference plot without soil disturbance is included. The effects of tillage intensity on N mineralization are determined by changes in mineral N contents in soil and total-N in

plant biomass. At maturity, total crop N uptake is determined and grain samples are analysed for baking quality parameters (WP4). This activity includes two growth years.

Activity 7: Mechanisms that control the retention and mineralization of labile organic N

The impact of tillage on C and N turnover in soil will be studied in further detail in incubation studies. Intact soil cores are sampled immediately before soil tillage is carried out in the field experiments in Activity 6. Following addition of ^{15}N -labelled ammonium, the effects of soil disturbance are followed by pool dilution techniques. The soil cores are subjected to controlled mechanical treatments supplying energy levels comparable to tillage operations in the field. Disturbed and undisturbed reference samples are incubated at 20°C. Evolved CO_2 is collected continuously during two weeks. Inorganic ^{14}N and ^{15}N is determined after one and two weeks of incubation. Relationships between C and N turnover in disturbed and undisturbed soils are established. Net effects of soil disturbance on inorganic N levels in soil obtained in the incubation study are compared with the measurements of inorganic N in the field and by crop N uptake.

WP3: Crop and weed competition and N uptake as affected by manure placement

Activity 8: Recovery of ^{15}N in crop and weeds

This activity will be situated in the organic dairy crop rotation at Foulumgård, Research Centre Foulum. The six course crop rotation is: Spring barley with under-sown clover-grass (field S04), 1st year clover-grass, 2nd year clover-grass, Spring barley-peas mixture with under-sown ryegrass (field S01), Oat with under-sown ryegrass, and Beets. Differences in soil fertility are obtained by selecting the two cereal growing fields on each side of the clover-grass for the experiment. A small amount of 99% ^{15}N -ammoniumsulphate will be applied to pig slurry just before application. The slurry will be applied by hand in framed micro-plots (30×40 cm) placed beforehand in the field. A few days after slurry application straight and dense rows of spring wheat will be sown by hand-held equipment (Petersen, accepted).

The main factor will be the distance (4, 10 and 16 cm) of the slurry band in relation to the crop row. Broad-spread slurry followed by incorporation will serve as reference treatment. Nitrogen loss by ammonia volatilisation is prevented, by reducing the exposure of the slurry to atmosphere. All treatments will be carried out in two sections: with and without competing weeds. A dense competing weed population will be ensured by sowing a mixture of weeds (*Galeopsis tetrahit* L., *Polýgonum persiária* L. and *Matricária marítima* L.). In field S04 the treatments will be established in several replicates for destructive sampling 6 times during the elongation phase of the crop for estimating the recovery course of applied ^{15}N . The last sampling will be performed just before ear emergence when maximum ^{15}N -recovery occurs (e.g. Petersen, accepted). In field S01 only one sampling is performed corresponding to the last sampling in field S04. All combinations of treatment (method for slurry application × weed occurrence) and sampling date will be complete randomised and performed in three replicates. Samples of crop and weeds are handled separately, and analysed for dry matter, nitrogen concentration and ^{15}N abundance. The results of nitrogen concentration and ^{15}N analysis are expected to be available not before December 2002. Detailed planning is in progress and will be finalised in February 2002.

Activity 9: Initial growth of roots

The root growth experiments is finished as planned and will be published as planned together with results from activity 10 at the end of 2002.

Activity 10: Competition between spring wheat and weeds

Deviations from the original plans are described under C3. The experiments in 2002 will be conducted similar to the experiments in 2001, hopefully with improved weather conditions.

WP4: Bread wheat quality as affected by crop variety and N management

Activity 11: Field trial Pajbjergfonden

The Danish plant breeding company "Pajbjergfonden" supplies the project with organic grown winter wheat varieties from a project with 48 winter wheat varieties grown in 4 replicated organic field trials. Two of these are without animal manure, one is fertilised with pig-slurry and one is fertilised with cattle-slurry. The field trials are repeated in 2002. Grain samples are delivered to laboratory analysis (Activity 13).

In 2002 approximately 900 wheat grain samples are to be collected for further analyses.

Activity 12: Field trial Research Centre Flakkebjerg

In the organic crop rotation area at Research Centre Flakkebjerg (FL1, EXUNIT) a field trial has been established to examine the competition and synergetic relations between winter bread wheat and green manure. The field trial will be repeated in 2002. Grain samples will be subjected to laboratory analysis at DIAS-PB and DIAS-FVFS.

Activity 13: NIT and image analysis

The grain analyses focus on qualitative traits of grains. These are measured preliminarily by Near Infrared Transmission (NIT) and image analysis. Development of calibration for NIT scanning allows analysis of wheat grains for content of protein, starch, gluten, water and zeleny number. Image analysis may be used for rapid determination of 1000 kernel weight, kernel shape and colour. Furthermore specific weight will be measured. Possibly development of new NIT calibrations will be attempted based on the flour analysis. Grain samples from Activity 11 and 12 and WP1-WP3 will be included. In 2002 the activity focuses on:

- Grain samples are analysed for protein, starch, water, gluten, zeleny, and test weight from activity 11 (harvest 2001 and 2002).
- An Access database for results and NIR scans will be developed.
- Preliminary validation of NIT methodology.

Activity 14: Flour analysis and baking characteristics

Flour analysis focus on content of protein, gluten and starch. Furthermore flour yield and particle size distribution are determined. The elasticity and extensibility of the gluten structure and the ability of the starch to gelatinise are characterised by rheological measurements. Baking characteristics will be conducted on selected samples in collaboration with the milling company "Drabæks Mølle". Grain samples from Activity 12 and WP1-WP3 will be included.

- From the field trial at Pajbjergfonden (activity 11, harvest 2000), 12 varieties were selected, with the purpose to characterise the baking potential. Grain samples from four organic and one conventional field trial were milled on a laboratory mill, and protein and gluten content have been determined. Levels of protein and gluten seemed to be low for nearly all samples.
- Spring wheat samples (harvest 99) from grazed grass/clover pastures are analysed with the aim to compare baking potential of wheat from fields with different levels of grazing and N-addition. Analysis included protein and gluten content."

Milestones:

- Rheological characterisation of gluten from samples 2000 (ultimo 2001)
- Milling and analysis of samples from 2001, Pajbjergfonden (Jan/Feb 2002)
- Baking characteristics of selected samples at Drabæks Mølle (Jan – May 2002)
- Milling and analysis of spring wheat samples from Askov (2001) (Mar – June 2002)
- Evaluation of preliminary results from 2000 and 2001(activity 13 and 14) (Aug – Dec 2002)

E. Project publications

Jørgensen, J.R., 2000. Protein gør det ikke alene. *Agrologisk - om markbrug*, 10:10-11.

Jørgensen, J.R., 2000. Er der lighedstegn mellem proteinprocent og kvalitet af hvede til human konsum? Efterårskonference 2000, 3. oktober 2000, Hotel Nyborg Strand. Bilag til Efterårskonference 2000, 36.

Jørgensen, J.R., 2001. Handels- og forbrugsmønstre i Danmark. DJF-rapport nr. 53, Produktion af kvalitetshvede i Danmark (ed. Waagepetersen, J., Petersen, J.B., Knudsen, L., Deneken, G. & Jørgensen, J.R), 22-24.

Jørgensen, J.R., 2001. Kvalitet af hvede til produktion af brød og andre produkter. DJF-rapport nr. 53, Produktion af kvalitetshvede i Danmark, (ed. Waagepetersen, J., Petersen, J.B., Knudsen, L., Deneken, G. & Jørgensen, J.R), 25-32.

Jørgensen, J.R., 2001. Kvalitet af sidstindlejret protein i kernen ved ekstra kvælstofgødsning. DJF-rapport nr. 53, Produktion af kvalitetshvede i Danmark, (ed. Waagepetersen, J., Petersen, J.B., Knudsen, L., Deneken, G. & Jørgensen, J.R), 67-70.

Jørgensen, J.R., 2001. Proteinafgrøder i økologisk jordbrug - Nøgen havre og højlysin byg Indlæg på møde vedr. Demonstrationsprojekt om Proteinafgrøder i økologisk jordbrug, Økologiens Hus, 5. april 2001

F. Scientific education (ph.d. and post doc.), including visiting scientists and visits abroad

None so far

G. National and international co-operation

- In the DARCOF programme 1 simulation of N fluxes in grazed pastures using the DAISY model was initiated in collaboration with Assoc. Prof. Dr. L.S. Jensen, Plant Nutrition and Soil Fertility Laboratory, The Royal Veterinary and Agricultural University. This collaboration continues in the present project.
- Collaboration with Department of Organic Farming at Christian-Albrechts-University of Kiel will be used in the interpretation of the nitrate leaching from pastures and quality wheat production (Prof. Dr. F. Taube and Dr. R. Loges).
- Root growth (winRHIZO) will be analyzed in collaboration with "Pajbjergfonden" and Kai Lønne Nielsen.
- The study on tillage effects on N turnover in soil will interact and draw upon the expertise in DARCOF II, Project I.7 ROMAPAC (project coordination Per Schjønning).
- The Danish plant breeding company "Pajbjergfonden" supplies the project with organic grown winter wheat varieties.
- Baking characteristics tests are conducted in collaboration with the milling company "Drabæks Mølle".
- Collaboration with Professor Lars Munck, Food technology (Spectroscopy and Chemometrics), Dairy and Food Science, Royal Veterinary and Agricultural University, on use of spectroscopy and chemometrics in quality determination in cereals.
- Erik Steen Jensen, The Royal Veterinary and Agricultural University (DARCOF II, project coordinator, Project I.5) has requested assistance with quality analysis of cereals used in their experiments.
- A project group with representatives from organic bread wheat farmers, the plant breeder "Pajbjergfonden and the milling company "Drabæks Mølle" will be established.