



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

II.3 Organic production of steers and use of bioactive forages in livestock

3. Head of project

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7. **Start of project: 01.05.2000**
End of project: 31.10.2004

8. Annual report 2001/Application for continuation in 2002

8A. Objectives and expected achievements (from application)

The overall objective is to develop and document economically viable production systems for organic meat (beef and pork) with emphasis on steer production that try to improve animal health and welfare, product quality and the natural value of marginal areas by grazing. Furthermore, bioactive forages with a possible influence on health and meat quality will be investigated. Specific goals:

- To describe and develop steer production on organic farms with focus on pasture based production, particularly grazing strategies
- To evaluate the effect of different management strategies on production, and health and welfare of organic steers.
- To compare production, parasitism and herbage intake in steers and heifers grazing marginal areas at different stocking rate or grazing systems.
- To examine the interaction of grazing, forage production, and development in biodiversity in marginal areas of different initial richness of species.
- To investigate the use of bioactive forages and products for improvement of health with particular reference to parasitic infections.
- To improve meat and eating quality in relation to fattening strategies and bioactive forages.

The investigations related to steer production will provide a scientific basis for guidelines to organic beef production and will support organic farmers in making decisions regarding production strategies in their own enterprises. The perspective of having bioactive plants helping in control of parasitic infections and/or improving meat quality and flavour are prosperous. It may limit the unwanted use of medication and prolonged withdrawal times are avoided. Also the combination of steer production with improvements and conservation of biodiversity of marginal land in low-lying areas seems very beneficial for nature conservation as well as environment. All of these different aspects may improve economy of organic steer production or will help justify the higher prices of organic products and improve the image of organic farming systems as being special compared to conventional farming systems. Nevertheless, concepts and ideas developed in the present study regarding use of bioactive forages will be equally applicable in conventional farming.

8B. Project summary (from application)

Organic meat production in Denmark covers mainly beef and pork. The present market share of organic beef is only 2% and the supply of organic high quality beef is thus restricted despite a steadily growing number of organic dairy farms. Economic profitability is seen as a major constraining factor in using dairy breed calves in beef production. However, the interest in organic meat production is increasing and the need for reliable information on production parameters and strategies is evident. The objective of this project is to contribute to development of economically viable production systems for organic meat (beef and pork). Emphasis is on steer production that try to improve animal health and welfare, product quality and nature value of marginal areas by grazing. This may provide a scientific basis for decision support to organic beef producers and provide future guidelines for management of marginal areas in order to increase biodiversity. The investigations include the use of selected forages with a possible influence on health and meat quality. This approach to improvement of meat quality and to health promotion, particularly parasite control, is novel and may limit the unwanted use of medication. It is thus the intention of the project to find ways of improving the internal and external quality of organic produce.

Table 1. Work package list (from application)

No	Work package title	Participants*	Budget 1.000 DKr	Start	End	Deliverable No
WP1	On-farm description and analysis of production and management strategies for steers	<u>SMT</u> , TK, BN	411	4/ 2000	2/2003	D19, D20, D21, D22, D23
WP2	Production strategies for steers on clover grass pastures	<u>SMT</u> , TK, BN	94	4/ 2000	2/2003	D13, D24
WP3	Grazing systems for steers on marginal land	<u>HRA</u> , TK, BN, <u>LLH</u> , BN	1,997	4/ 2000	12/200 3	D15, D29, D30
WP4	Influence of different grazing strategies on biodiversity on marginal land	<u>ABH</u> , KS	810	4/ 2000	12/200 2	D2, D15, D18, D27, D28
WP5	Preparation of extracts for estimation of direct anthelmintic effect of plant species	<u>KB</u>	376	8/ 2000	12/200 3	D1, D5, D6, D10
WP6	Influence of bioactive forages on animal health with emphasis on parasitic infections	<u>SMT</u> , AR	1,242	4/ 2000	6/2004	D7, D14, D16, D35, D37
WP7	Test and large scale cultivation of bioactive forages	(<u>CO</u>), <u>KS</u>	376	4/ 2000	6/2004	D8, D9, D31
WP8	Influence of bioactive forages on meat and eating quality	<u>LLH</u> , MM, AR, CO, TK, SMT, DB	1,264	1/ 2001	6/2004	D17, D34, D36

* Responsible participants are underlined

8C. Progress

8C.1 Annual description (resume) of main results and conclusions

WP1: On-farm descriptions and analysis of production and management strategies for steers

The overall production from the 6 farms showed a daily gain of 577 - 823 g/day (year 2000) and 569 - 957 g/day (year 2000/2001) on pasture and in the barn respectively. Calves with a liveweight below 140 kg at turn-out had a low gain in the whole grazing period (250-400 g/day). The feed consumption was 1820-1950 Scandinavian Feed Units (SFU) per steer/year. In the summertime the feed ration was composed of grass for 70-80%. In the winter feed ration 15 to 39% cereals and concentrates were used.

Monthly recordings of welfare of steers in the winter and summer period are done on 6 farms. The preliminary results from 2 farms indicate no serious welfare problems either in the winter nor in the summer period. However, ringworm (dermatomycosis) is observed on over 50% of the steers in the winter period, and coughing is periodically observed in the summertime.

Recordings of steers in the finishing period are done as well (table 2). All steers were recorded when starting the finishing period and there is focus on feed consumption, body condition and slaughter weight in relation to slaughter results (M2). The results show high variation of management of finishing steers between the farms. Additionally, the meat quality is influenced by several factors and seemed to be effected by individual factors as daily gain during their whole life.

To supply the finishing strategies on the farms, an experiment has focused on finishing of steers on clover grass pasture with and without cereals (task 2). The results showed that supplementing with 4 kg cereals in 2 months before slaughtering have only minor effect on slaughter weight and conformation. This experiment, performed at Ammitsbøl Skovgaard, replaced the experiment outlined in M1.

Table 2. Production results for fattening steers and slaughter data

	Farm 149	Farm 309	Farm 409	Farm 419	Farm 649
No of steers	42	31	22	31	42
Live weight at start, kg	444 ± 36	619 ± 48	449 ± 69	516 ± 51	468 ± 63
Slaughter weight, kg	553 ± 44	683 ± 47	605 ± 37	620 ± 53	522 ± 43
Carcass weight, kg	283 ± 18	340 ± 22	300 ± 19	332 ± 26	257 ± 22
Slagtealder, måneder	26,9 ± 2,2	28,5 ± 1,9	24,0 ± 1,7	22,8 ± 0,6	23,9 ± 1,4
Days fattened	79 ± 4	66 ± 23	128 ± 41	105 ± 48	101 ± 72
Weight gain, g/day	1346 ± 534	726 ± 927	1106 ± 216	1017 ± 425	585 ± 247
<i>Feeding:</i>					
(SFU/animal/day)	3,7	4,4	2,9	2,9	0
Cereals Total	10,4	13,8	8,9	10,5	5,7
Feed utilization, SFU/kg gain	9,25	12,5	8,2	15,4	12,7
<i>Carcass data:</i>					
- Conformation	4,6 ± 0,9	4,1 ± 0,5	4,4 ± 1,0	4,8 ± 0,6	3,5 ± 0,7
- Fat	3,1 ± 0,3	2,9 ± 0,5	3,1 ± 0,5	3,2 ± 0,5	2,0 ± 0,4
- Colour	3,0 ± 0	3,1 ± 0,3	3,0 ± 0	3,0 ± 0	3,4 ± 0,5

Studies were performed in 2000 on 2 organic farms to determine the effect of supplementation with energy and with or without a high level of protein (EP and E) to 3-5 months old dairy calves grazing clover grass pastures on performance. Daily gain in the 8 weeks with supplementation was for Farm I 1216 and 1042 g/day and for Farm II 1071, 671 and 770 g/day for group EP, E and Eres (reduced amount of barley) respectively. Daily gain for group EP was higher than for group E and Eres ($P < 0.01-0.001$), 17 – 49% for Farm I and II respectively. However, compensatory growth was observed in the period after supplementation until housing, resulting in a live weight at housing with only minor differences between groups. No differences in daily gain were observed between supplementation of barley of 0.4 or 2 % of BW. Higher levels of oocyst excretion were observed on Farm II where the pasture had been grazed by cattle the previous year compared to the uninfected pastures of Farm I. However, levels were generally low and no clinical coccidiosis was observed on any of the 2 farms. Subclinical coccidiosis caused low faecal dry matter and reduction in daily gain (220 g/day) in calves with oocysts per g of faeces > 5000 once in the experimental period.

WP2: Production strategies for steers on clover grass pastures

All samples from the 2 experiments done in 2000 are prepared for the alkane analysis (experiment 1: herbage intake for Holstein Friesians steers fed on 2 energy levels in the winter period; experiment 2: herbage intake for Holstein Friesians and Jersey steers). All faecal and herbage samples are just being analysed for alkanes (gaschromatography)

WP3: Grazing systems for steers on marginal land

Grazing season 2001

Fourty steers and 40 heifers were selected for the trial according to age and genetic makeup (sire). The bull calves were castrated on 13 March. Turn out was at 23 May. Due to heavy rain in September (180 % compared to normal) the animals were housed two weeks earlier than planned and the grazing season therefore ended on 26 September.

During the grazing season 5 animals were treated for interdigital dermatitis. Heavy gastrointestinal nematode infections were acquired in most groups in early season and contributed to several cases of diarrhoea and reduced weight gain, particularly in G3 and G6 groups, irrespective of grazing systems (table 1). This can be considered as incidents of early season gastroenteritis related to a high level of over-wintering infection. Two animals in G6 were treated with anthelmintic (fenbendazole) due to persistent diarrhoea on 29 June. Single animals with lungworm infection (dictyocaulosis) were observed 10 July in G3S and G3R, increasing to high levels of excretion, 90-100 % prevalence and clinical symptoms on 26 September. The G3-groups were treated on 30 September. Lungworms were not detected in the other groups. In summary, the grazing systems did not differ markedly in levels of nematode infections over the season. Major differences between heifers and steers were not noticed but this will be further examined.

Table 3. Mean faecal egg counts (egg per g of faeces) in the 4 replicates (steers and heifers combined). Fussingø 2001

Group	Grazing system	Date					
		23 May	7 June (move)	10 July (move)	7 August	28 August (move)	26 Sept.
G3S	Set-stocked	0	14	478	253	134	16
G3R	Rotation	0	12	674	334	266	8
G4S	Set-stocked	0	24	14	34	120	212
G4R	Rotation	0	44	114	60	126	166
G5S	Set-stocked	0	28	286	326	134	118
G5R	Rotation	0	118	388	264	174	126
G6S	Set-stocked	0	62	370	388	328	98
G6R	Rotation	0	48	282	172	334	180

Mean daily live weights (g) of groups from turn out (35/5) to five dates in relation to moving to new paddocks and turn in are shown in the table 4.

Table 4. Daily live weight gain (g) on pasture. Fussingø 2001

Group	Grazing system	Period (from 23/5)				
		7/6	10/7	7/8	28/8	26/9
Steers	Setstocked	397	798	652	565	478
Steers	Rotation	257	735	626	488	470
<i>Mean</i>		327	767	639	526	474
Heifers	Setstocked	342	690	594	505	450
Heifers	Rotation	158	651	563	458	404
<i>Mean</i>		250	670	579	481	427
Heifers + steers	Setstocked	369	744	623	535	464
Heifers + steers	Rotation	208	693	594	473	437
<i>Mean</i>		289	719	609	504	450

Individual weight gains for the whole grazing season ranged between 80 and 788 g/day. The daily weight gains were approximately 200 g less than expected, although the amount of grass (kg DM per ha) was considered to be sufficient.

Only slight differences were observed between sex (steers and heifers) and depending on grazing system (set-stocking and rotation). No differences were expected regarding sex but the rotational system was expected to give higher weight gains than set-stocking. Further analysis will be done taking recordings of grass biomass, growth and quality into account.

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Pasture intake

The feed intake was investigated in 14 heifers and 13 steers distributed in 3 paddocks with set-stocking in the Fussingø experiment. A ruminal alkane bolus was administered to each animal on June 7 2001. On June 14, 18, 20 and 22 rectal faeces was sampled from all animals and the samples pooled on an equal dry weight basis.

Faecal dry matter has been estimated on all samples. The dry matter percentages were 10,06% for heifers and 9,17% for steers and 8,71%, 9,98% and 10,16% in paddock 31, 51, 61 respectively.

The samples are now prepared for alkane analysis (gaschromatography) and microhistology. This is likely to be finished by February 2002. There will also be an evaluation of the alkane methods usage in determining the animals selections of plants.

WP4: Influence of different grazing strategies on biodiversity on marginal land

The paddocks grazed continuously and rotationally by heifers and first-year steers (WP3) have been characterized 6 times during the season at changes in paddocks, turning out and housing. The sward structure has been measured by plate raising meter and analysed as a frequency measurement. The analysis of data on the structure of vegetation has been initiated (2000-data) for publication at EGF2002 (L. Nielsen, A.B. Hald & J.H. Badsberg: Sward structure measurements to monitor the effect of grazing in nature management situations).

The grazing pattern has further been examined throughout a month in a single rotation. In an 40 x 60 m area sward height and dominating plant species were examined in 72 points. Herbage allowance and herbage production in the paddocks were calculated from sward height and a sward height/herbage mass correlation made by 300 herbage samples during the season. The samples were taken by scissors to 2 cm above ground level. Herbage quality was estimated in these samples and in samples taken by hand, where grazing was simulated. The results are not completely analysed.

WP5: Preparation of extracts for estimation of direct anthelmintic effect of plant species

Task 15. A list of 30 species with a likely effect on livestock nematodes based on literature was prepared in early 2000. The collection of plants was performed during the grazing season (see WP4).

As described in the previous status report, while the extraction method superficially appears to work nicely, something is wrong with it, since the control samples, without plant material, also inhibit the growth of the larvae, although less than the samples with bioactive plant materials. Further work has been done since then with the laboratory extraction procedure, in close collaboration with WP6, and almost every possible modification has been done to determine what is the problem with the control samples. At present it seems that the problem is related to a too high addition of salt (NaCl) during the procedure, which is a result of the method for adjustment of pH. So a new modification will be made, where the additions of acid and base are kept at a minimum, by using less concentrated buffers, and the electrical conductivity monitored during the procedure, to ensure that it stays so low that it cannot harm the larvae. Due to these problems all the work of this WP is seriously delayed, and much more time has been spent on method development than what was originally expected. On the other hand, we have now obtained a very thorough understanding of how the procedure functions, so once we get it to work, we are still confident that the remaining tests will be easy to carry out, and that in the end we will be able to provide most of the deliverables that were originally planned. We now understand why no prior publications mention this seemingly simple and obvious method, but of course this means that the impact of the work, once we succeed, will be correspondingly larger.

In conclusion, since we have now found a solution that may solve the problems, it is still realistic to carry out most of the work proposed for this task, but the completion will be somewhat delayed, at least until May 2002.

On the other hand, the unexpected problems has had the consequence that the resources for task 16, which was supposed to follow up on the work of task 15, are no longer available in the project. However, fortunately, corresponding work is included in the EU-project WORMCOPS, and here the resources seem to be sufficient to cover this work. So even though the budget for WP5 in 2002 is going to be unchanged, and thus rather small, it is still the intention, and quite likely, that this task will be completed, before the end of 2002. If we do not succeed with the procedure of task 15, in the plans for WORMCOPS we have devised an alternative strategy for obtaining essentially the same information: Rather than depending on a simulation of the processes taking place during digestion, we will simply feed a sheep with a bioactive forage for a day or two before it is slaughtered, and analyse material from each part of the real digestive tract. For tannins some of this work may be covered by the work of the M.Sc. student Christina Guldborg-Hansen. The same can be done with pigs in the present project, if we have resources to do it at the corresponding time.

Task 17. Before the end of 2001 analysis for total tannins will be made on the plant material for which where this test is required, and again in 2002 and 2003. Some of the planned analyses of fructans (inulin) have been taken over by Knud Erik Back Knudsen in DJF, Foulum. This will allow a correspondingly larger number of measurements of tannin-like compounds.

WP6: Influence of bioactive forages on animal health with emphasis on parasitic infections

Samples for worm counts from the 2000 trial were processed in spring 2001. In summary, the investigations in 2000 showed a 50% reduction in egg counts in lambs grazing sulla or sainfoin (*Onobrychis viciifolia*) compared to a pure stand of white clover. The reductions in worm counts (*Ostertagia circumcincta* and *Trichostrongylus vitrinus*) were less (20-30%). The largest reductions were observed in the groups grazing on sulla, particularly in *T. vitrinus*. Details in the enclosed abstract from WAAVP2001. A full paper is being prepared and will be submitted in 2001 as planned.

The objectives in year 2001 were to investigate the effect of feeding leguminous crops (sulla, sainfoin, *Lotus corniculatus*) with a high content of CT or chicory on both established and establishing infections with gastrointestinal nematodes in lambs. Furthermore effects on eggs and larvae were assayed by *in vitro* cultures. A group of 69 ram lambs (parasite naïve, Shropshire) were turned out on a parasite-free clover grass pasture on 10 July. After 6 days, 4 groups of 7 lambs (PRE-groups) were trickle infected with 4 x 2500 infective larvae of *O. circumcincta* and *T. vitrinus*. Five groups of 7 lambs were not infected (POST-groups). Another 6 lambs remained uninfected and served to determine any infection being picked up during the entire trial (tracers).

On 13 August, one PRE-group was killed for worm counts. At the same time, all other groups were moved onto paddocks with bioactive forages according to the following plan:

1. clover grass – acting as control plot (one PRE- and one POST-group + 2 tracer lambs)
2. sainfoin (one PRE- and one POST-group + 2 tracer lambs)
3. sulla (one PRE- and one POST-group + 2 tracer lambs)
4. *Lotus corniculatus* (one POST-group)
5. chicory (one POST-group)

The POST-groups were trickled infected (4 x 2500 infective larvae of *O. circumcincta* and *T. vitrinus*), starting immediately after turnout on bioactive forages. In order to prevent any autoinfection, all lambs were moved every 4-6 days to a new clean area within the paddock (total of approx. 60 sub-paddocks !!). Following grazing for 4½ and 5½ weeks on the bioactive crops, respectively, PRE- and POST-groups (+tracers) were slaughtered for worm counts of abomasum and small intestine. The growth of the sulla was not satisfactory due to a dry spell in July after which the crop ceased to grow and this probably affected the result. Preliminary examination of the mean faecal egg counts shows a marked reduction (up to 50%) in the PRE-groups on sainfoin and sulla compared to clover grass. This indicates that particularly sainfoin can be used to reduce egg counts in already infected lambs. Similar to the findings in 2000, a very favourable response in the POST-group grazing the sainfoin in comparison to clover grass (a 50% reduction) whereas faecal egg counts on sulla were not reduced. The latter could be related to a reduced feed intake and thus reduced faecal output and consequently higher egg concentration in faeces. The number of animals in this experiment was doubled due to complementary funding from our EU-project WORMCOPS.

WP7: Test and large scale cultivation of bioactive forages

Plots for harvest are established at Foulum in 2001 with different bioactive forages; chicory (*Chichorium intybus*), birdsfoot trefoil (*Lotus corniculatus*), big trefoil (*Lotus pedunculatus*), sulla (*Hedysarum coronarium*), Jerusalem artichoke (*Helianthus tuberosum*) and sainfoin (*Onobrychis viciifolia*). Perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) are grown as references. However, the growth of sulla and sainfoin has not been satisfactory, even that they are inoculated, as well as the growth of Jerusalem artichoke. The plots are harvested three times during the growing season. The results of herbage quality are still not available. Chicory with a high content of inulin has been grown at Rugballegård for the feeding experiment with pigs (WP8).

WP8: Influence of bioactive forages on meat and eating quality

No activities planned for year 2000 but an inulin rich cultivar of chicory has been collected in November 2000 at Beder Gartnerskole, Malling. In a pilot study the inulin-rich cultivar was tested for palatability of the blended chicory roots by two fattening pigs at Research Centre Foulum. The two 60-80 kg live-weight pigs were able to eat 2.6 kg blended chicory roots plus 2.3 kg concentrate. The chicory

roots inulin content was around 18 percent and the content of feed units for pigs was as high as 33.1 SFUs per 100-kg chicory roots.

According to these results the first of two pig experiments has been planned to begin the 5th of November 2001. The experiment consists of 4 treatments each of eight pigs plus extra 8 pigs. All 40 pigs totally free of parasites will be infected with a specific parasite in the period between 5 November and 10 December. The 40 pigs (20 intact male and 20 female pigs) are kept in litters of 8 pigs and fed 100 % organic concentrate and semi ad libitum grass silage (se WP 6). Eight pigs half of each sex are slaughtered on 10 December (se WP 6). From 10 December the 32 pigs will be distributed to the four treatments according to litter and sex in individual pens. Treatment one is a (conventional) control group given 100 energy % organic concentrate and no roughage from 10 December until slaughter. Treatment two is an organic control group given 95 energy % organic concentrate and semi ad libitum grass silage from 10 December until slaughter. The 30 % blended chicory roots on energy bases plus 70 % organic concentrate will be given from 10 December until slaughter of treatment 3. Treatment four is given 95 energy % organic concentrate and semi ad libitum roughage from 10 December until 14 January. From 14 January until slaughter of treatment 4, 30 % blended chicory roots on energy bases plus 70 % concentrate will be given. Finally, 16 male pigs will be slaughtered 11 and 16 female pigs 12 February 2002 for measuring meat and eating quality according to the plan.

8C.2 Fulfilment of tasks and deadlines in individual work packages

WP1: On-farm description and analysis of production and management strategies for steers		
	Time schedule according to application	Deviations, if any*
Task		
1 Description and evaluation of existing steer production	5/2000-9/2002	
2 Examination of different winter feeding regimes	11/2000-4/2001; 11/2001-4/2002	
3 Investigation of grazing strategies including adaptation to grazing	5/2000-10/2000; 5/2001-10/2001	
Deliverables		
19 Report: Production strategies in steer production: A model	11/2002	
20 Report: Grazing strategies for dairy breed steers with focus on calves	11/2002	
21 Paper: Effect of different finishing strategies on steer production on organic farms	11/2002	
22 Paper: Supplementation and adaptation of calves to grazing	11/2002	
23 Paper: Evaluation of different winter feeding strategies for steers on organic farms	11/2002	
Milestones		
1 Comparison of grazing strategies for steers and calves	12/2000 + 12/2001	
2 Comparison of winter feeding strategies in steer production	2/2001 + 7/2002	
3 Evaluation of models of welfare and production strategies	6/2002	
* <i>Deviations are to be further discussed at C3</i>		

WP2: Production strategies for steers on clover grass pastures		
	Time schedule according to application	Deviations, if any*
Task		
4 Estimation of herbage intake following different winter feeding levels	6-7/2000	
5 Developing a model for feeding management and time for slaughter	5/2000-4/2002	

Deliverables		
13 Paper: Feed intake in dairy breed steers on clover grass pasture and on wet riparian pasture	12/2001	
24 Popular paper: Body condition as a management tool in organic steer production	11/2002	
Milestones		
4 Estimation of feed intake by steers on clover grass pasture	9/2000	Delayed
5 Development of a model for using body condition score as a management tool in steer production	6/2002	
<i>* Deviations are to be further discussed at C3</i>		
WP3: Grazing systems for steers on marginal land		
	Time schedule according to application	Deviations, if any*
Task		
6 Evaluation of different stocking rates and grazing strategies	5-10/2000; 5-10/2001	
7 Estimation of herbage intake following different winter feeding levels	6-7/2001	
8 Evaluation of different grazing strategies and finishing diets including bioactive forages	5/2001-2/2003	
9 Examination of meat quality from steers in task 8	11/2002-2/2003	
Deliverables		
15 Paper: Grass intake, liveweight gain and parasite load in steers and heifers compared to grazing strategy, sward structure and herbage quality	6/2002	
29 Paper: Liveweight gain, parasite load and slaughter results in steers grazing in rotational versus continuous grazing systems.	6/2003	
30 Popular paper: Steer production on marginal land	6/2003	
Milestones		
6 Comparison of herbage intake in co-grazed steers and heifers	8/2001	Delayed
7 Comparison of performance of 1-year grazing steers and heifers	12/2001	
8 Evaluation of the effect of different grazing strategies on production and health of steers	3/2003	
9 Establishment of the relationship between finishing strategy and fatty acids in meat	5/2003	
<i>* Deviations are to be further discussed at C3</i>		
WP4: Influence of different grazing strategies on biodiversity on marginal land		
	Time schedule according to application	Deviations, if any*
Task		
10 Evaluation of sward production and herbage quality under different grazing strategies	5-10/2001; 5-10/2002	
11 Evaluation of effect of grazing heterogeneity on sward structure	5-10/2001; 6-8/2002	
12 Examination of biodiversity dynamics	11-12/2000; 6-12/2001; 6-7/2002	
13 Inventory of plants	7-12/2001	
14 Occurrence of bioactive plants in swards under different grazing strategies	6-7/2001; 6/2002	

Deliverables		
2 Delivery of plant species from WP4 to WP5	7/2000	OK
15 Paper: Grass intake, liveweight gain and parasite load in steers and heifers compared to grazing strategy, sward structure and herbage quality	6/2002	
18 Popular paper: A challenge for organic farmers: steer production for maintenance of biodiversity including bioactive plants of low-lying marginal areas (In Danish)	6/2002	
27 Paper: Organic steer production for maintenance of biodiversity of low-lying marginal areas	12/2002	
28 Paper: Bioactive plants in long-term swards with a high or low botanical diversity	12/2002	
Milestones		
10 Evaluation of sward structure dynamics	11/2001	
11 Evaluate the content of bioactive plants in the swards with different botanical composition	12/2001	
12 Evaluation of bioactive plants, forage production and quality in relation to grazing strategy	12/2001 + 12/2002	
13 The dynamics in biodiversity are analysed	3/2002 + 12/2002	
* <i>Deviations are to be further discussed at C3</i>		
WP5: Preparation of extracts for estimation of direct anthelmintic effect of plant species		
Task	Time schedule according to application	Deviations, if any*
15 Development of controlled degradation procedure	8/200-2/2001; 10/2001-1/2002	Delayed (5/2002)
16 Estimation of secondary metabolites e.g. condensed tannins in the gut mimetic procedure	1-3/2001	Delayed (12/2002)
17 Analysis of inulin and tannin content in bioactive forages	(continuously)	OK
Deliverables		
1 Determinations of inulin and condensed tannins in forages	2000-2003	OK
5 Report: Development of a gut-mimetic system for extraction of bioactive secondary metabolites	12/2000	Delayed (4/2002)
6 Extracts of cultivated plants	12/2000	Delayed (4/2002)
10 Extracts of wild plants	12/2001	Delayed (4/2002)
Milestones		
14 Development of a gut-mimetic system for extraction of bioactive secondary metabolites	10/2000	Delayed (5/2002)
15 Extracts of cultivated and wild plant species for testing of anthelmintic activity	12/2000 + 10/2001	Delayed (5/2002)
* <i>Deviations are to be further discussed at C3</i>		
WP6: Influence of bioactive forages on animal health with emphasis on parasitic infections		
Task	Time schedule according to application	Deviations, if any*
18 Evaluation of anthelmintic activity of plant extracts (<i>in vitro</i> studies)	5/2000-12/2001	Delayed
19 Evaluation of anthelmintic effect of bioactives forages in grazing ruminants	5-10/2000; 5-10/2001; 5-10/2002	
20 Evaluation of anthelmintic effect of bioactives forages fed to pigs	5-10/2001; 5-10/2002	Delayed
21 Studies on antiparasitic effect of chichory in pigs after palatability test	11/2001-2/2002; 11/2002-2/2003	

Deliverables		
7 <i>In vitro</i> assays for anthelmintic activity of plant extracts	12/2000	Delayed
14 Paper: <i>In vitro</i> studies of the anthelmintic effect of bio-active plants on infective larvae of bovine and porcine parasites	12/2001	Delayed
16 Paper: <i>In vivo</i> studies of the anthelmintic effect of bioactive plants on helminth parasites in sheep	6/2002	
35 Identification of plant/forages with short or long term anthelmintic effects	6/2004	
37 Paper: <i>In vivo</i> studies of the anthelmintic effect of bioactive plants on helminth parasites in pigs	10/2004	

Milestones		
16 Development of <i>in vitro</i> methods for evaluating anthelmintic activity	12/2000	Delayed
17 Comparison of <i>in vitro</i> anthelmintic activities of different plant extracts	12/2001	Delayed
18 Evaluation of anthelmintic effects of inulin-rich chicory in pigs	4/2002 + 12/2003	
19 Assessment of anthelmintic effects of different forages/plants in lambs	12/2002	
20 Screening of anthelmintic effects of different forages/plants in pigs	12/2003	

* *Deviations are to be further discussed at C3*

WP7: Test and large scale cultivation of bioactive forages		
Task	Time schedule according to application	Deviations, if any*
22 Evaluation of limiting factors for establishing bioactives forages (laboratory test)	5-12/2000	Cancelled
23 Evaluation of culturing bioactive forages (plot study)	5-10/2000; 5-10/2001	Phase in 2001 OK
24 Field testing of bioactive forages grazed by lambs	5-10/2001; 5-10/2002	OK 2001: exp. at KVL only
25 Evaluation of chicory fed to slaughter pigs and steers	5-9/2001; 5-9/2002; 5-9/2002	

Deliverables		
8 Forage for lambs	7/2001 + 7/2002	OK 2001: exp. at KVL only
9 Silage for pigs and steers	8/2001 + 002 + 003	OK
31 Paper: Growth and quality of bioactive plants	10/2003	

Milestones		
21 Laboratory establishment of bioactive crops completed	12/2000	Cancelled
22 Analysis of data collected from large scale production of silage to pigs and steers	10/2001+10/2002+ 10/2003	OK 2001
23 Evaluation of bioactive stands from small plots or grazing studies	10/2002	

* *Deviations are to be further discussed at C3*

WP8: Influence of bioactive forages on meat and eating quality		
	Time schedule according to application	Deviations, if any*
Task		
26 Evaluation of meat and eating quality and putative anthelmintic effect of bioactive forages fed to pigs	11/2001-2/2002; 11/2002-2/2003	OK
27 Evaluation of effect of bioactive forages in the finishing ration for steers on sensory quality at slaughter and fatty acids composition	11/2002-2/2003	One month earlier
Deliverables		
17 Report: Preliminary report on the effect of a bioactive forage on meat and sensory quality in pigs	6/2002	
34 per: Effect of different finishing strategies and a bioactive forage on meat and sensory quality in steers	12/2003	
36 Paper: Effect of chicory on meat and sensory quality in pigs	10/2004	
Milestones		
24 Assessment of the influence of chicory (and a related bioactive species) on meat and sensory quality in pigs	4/2002 + 4/2004	
25 Evaluation of the effect of different finishing strategies on fatty acids composition and sensory quality in steers fed a bioactive forage	6/2003	

* *Deviations are to be further discussed at C3*

8C.3 Discussion on the progress, incl. deviations and achievements in the project as a whole and in the individual work packages and

In general, the project is progressing as planned but there are some deviations:

WP1: In WP1 task 3 was cancelled in 2001 because the farmer ended the steer production just before the experiment should start. Instead, an experiment with finishing steers has been carried out at Am-mitsbøl Skovgaard as described at 8C1. The experiment on winter feeding described in task 2 was changed to registration of finishing steers, as this subject was more relevant.

WP2+3: Due to preparations of the samples for alkane analysis some results are delayed (M4 and M6).

WP5: the delay is thoroughly explained by technical difficulties mentioned in section 8.C1

WP6: Task 18 and 20, deliverables 7+14 and the corresponding M16 and M17 are delayed for the reasons explained under WP5.

WP7: M22 includes the production of chicory roots.

In WP8 the original plan of task 26 has been followed until now. The first pig experiment is planned to start 5 November 2001, according to the plan. In task 27 the final feeding of the steers with the bioactive plant chicory are planned to begin 1 October 2002, one month earlier according to the plan.

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: On-farm descriptions and analysis of production and management strategies for steers

The recording of production factors continues on 5 farms as 1 farmer stopped the steer production. Welfare recordings continue until December 2001, and recordings of steers in the finishing period continues in 2002. A publication concerning the experiments with calves on pasture is under preparation.

WP2: Production strategies for steers on clover grass pastures

The alkane analysis will be finished in 2001, and a publication concerning the herbage intake is supposed to be finished in spring 2002.

WP3: Grazing systems for steers on marginal land

Winter feeding 2001-2002

A ration consisting of 48 % barley whole crop silage, 28 % grass pellets, 23.3 % barley straw and 0,7 % minerals (dry matter basis) will be fed *ad libitum*.

The ration is composed to reach weight gains of 700 g/day during the winter period, although the planned weight gain of 700 g/day was not reached on pasture. The reason for choosing 700 g/day in the housing period is that higher weight gains through the winter period are expected to have negative influence on the next grazing season.

This will affect the weight of the animals following the grazing season 2002 being lower than planned and this will affect the outcome of the trial.

Grazing season 2002

The trial will continue as planned in the grazing season 2002 as it is not possible to adjust the stocking rate to illuminate lower production during this season.

Winter feeding 2002-2003

Chicory roots will be used in the finishing ration. The effect of feeding Chicory roots will be compared to effect of feeding barley restricted in a ration of *ad libitum* silage feeding. The period will last for 100 days.

During fall 2001 feeding of Chicory roots will be tested on young stock on Rugballegård to see how willing the animals are to eat the roots when mixed in a full fodder. The nutritional value of Chicory will be analysed by traditional methods.

WP4: Influence of different grazing strategies on biodiversity on marginal land

In the grazing season 2002 second-year steers will graze the paddocks (WP3). Measurements concerning sward structure, grazing pattern, herbage allowance, herbage production and herbage quality will be made as in 2001. Data analysis of the results will contribute to milestones (M11, M12 and M13) and publications (D15, D18, D 27 and D28).

WP5: Preparation of extracts for estimation of direct anthelmintic effect of plant species

Plans for 2002 include the fulfilment of task supposed to have been finished in 2001 – see section 8.C1 for details.

WP6: Influence of bioactive forages on animal health with emphasis on parasitic infections

A grazing trial with a limited number of animals will be performed at KVL with selected bioactive plants (primarily sainfoin, as this crop looks most promising). The experiments with pig are described under WP8.

WP7: Test and large scale cultivation of bioactive forages

The plot experiment with different bioactive forages will continue and there will be worked at a better growth result for sulla, sainfoin and Jerusalem artichoke.

Chicory will be produced at Rugballegård for feeding experiments with steers (WP8).

WP8: Influence of bioactive forages on meat and eating quality

The first pig experiment is planned to start the 5th of November 2001 and the steer experiment primo

October 2002. The second pig experiment is planned to begin October or November 2002.

The plan of the steer experiment depends on a pilot study where minced chicory roots as well as silage of the top of an inulin rich cultivar will be tested for palatability by heifers at Rugballegaard, Research Centre Bygholm in the autumn 2001. The plan until now is to use minced roots from an inulin rich cultivar for final feeding of steers. The preliminary plan is to compare two different energy levels of chicory roots (2 and 4 feeding units) having a lot of bitter compounds with expected effect on eating quality with the same energy levels of barley in a period of 100 days. All 4 treatments added ad libitum clovergrass/barley/pea silage. May be silage of the top from the inulin rich cultivar for final feeding of steers also will be possible.

The plan of the second pig experiment depends on the results of the first pig experiment. Further more there is no money for sensory evaluation in the second pig experiment at the moment. However, a complementary research application aims to solve that problem. The title of complementary research plan is in Danish: Produktkvalitet i økologisk kødproduktion i relation til afgræsning og fodring med bioaktive afgrøder og afsætning af studekød. Interessetilkendegivelse til forskningsprogrammet "komplementerende forskning i FØJO II" 2001-2005, 3/9 2001.

8E. Project publications

1. Articles in international, scientific journals with review procedures

Nielsen, B. & Thamsborg, S.M. Dairy bull calves as a resource for organic beef production: A farm survey in Denmark. *Livestock Production Science*. Accepted.

2. Presentations at congresses, symposiums etc.

Andersen, H. Refsgaard & Troels Kristensen, 2001. Studeproduktion på marginaljorde og kløvergræsmarker. I: Økologisk Kvægproduktion. Bilag til temadag, 3. oktober 2001. DJF & FØJO, p. 31-33.

Eriksen, L., Thamsborg, S.M. & Gunnarson, A. Ehrlichia phagocytophilia infection in calves and lambs during their first grazing season at a riparian meadow in Denmark. Danish Society of Parasitology and Danish Society of Tropical Medicine and International Health Joint Spring Symposium, March 2001.

Nielsen, B & Thamsborg, S. 2001. Organic beef production with emphasis on feeding and health of dairy bred bull calves. Proceedings from the NAHWOA-workshop (Breeding and Nutrition). (oral presentation)

Thamsborg, S.M., Mejer, H. & Roepstorff, A. Sainfoin reduces the establishment of nematode infections in grazing lambs. Proc. 18th Int. Conf. of the WAAVP, Stresa, Italy, 2001 (oral presentation).

Thamsborg, S.M. Options for parasite control using tanniferous forages in livestock in Northern temperate areas. Proc. 18th Int. Conf. of the WAAVP, Stresa, Italy, 2001 (oral presentation).

3. Articles in agricultural journals etc.

Andersen, H. Refsgaard & Troels Kristensen, 2000. Studeproduktion. Årsberetning, 1999. Danmarks JordbrugsForskning, 30-31

Nielsen, B. & Thamsborg, S. 2001. Økologiske tyrekalve opfedes i konventionelle besætninger. Økologisk Jordbrug. 9.3.2001 side 12.

Nielsen, B. & Thamsborg, S. 2001. Stude på græs. Økologisk Jordbrug. 20.4.2001 side 9.

Nielsen, B. & Thamsborg, S. 2001. Kalve skal kastreres tidligt. Økologisk Jordbrug. 6.4.2001 side 10.

Nielsen, B. 2001. Opfødning af økologiske tyrekalve og stude. Forskning i økologisk jordbrug. Nyhedsbrev fra FØJO. maj/juni 2001, nr.3. 1-2.

Nielsen, B. 2001. Udvikling af økologisk produktion af oksekød. Forskningsnytt om økologisk landbrug i Noden. Sveriges Lantbruksuniversitet. 4, 4-6.

Nielsen, B. 2001. Tre ud af fire tyrekalve mærkes med "ud" i stedet for "Ø". *Bovilogisk Tidsskrift* 7/2001. 22-23.

4. Other presentations at meetings, field days etc.

- Andersen H. Refsgaard, 2001. Indlæg ved møde for Landsforeningen af Danske Slagtekalveproducenter d. 20 juni, 2001 i Ødsted. Emne: Studeproduktion - foreløbige resultater af danske undersøgelser.
- Andersen, H. Refsgaard, 2000. Studeproduktion på marginaljorde og på kløvergræsmarker. I: Årsmøde 2000. Nyt byggeri, ny teknologi, nye indtægtskilder i kvægbruget. Landsudvalget for kvæg, 56-57
- Nielsen, B. 2001. Økologisk oksekødsproduktion – resultater fra gårdstudier. Proceedings of the meeting "Organic cattle production" the 3.10.01, Foulum. 27-30. (oral presentation).
- Nielsen, B. 2001. Status vedr. økologisk oksekødsproduktion. Afgræsning på marginaljord eller sædskiftejord? Lecture at meeting "Organic steer production", June 2001, Ammitsbøl Skovgaard. (oral presentation). Also contributions from H. R. Andersen, T. Kristensen and S.M. Thamsborg.

8F. Scientific education (ph.d. and post doc.), including visiting scientists and visits abroad

WP1+2+3 form part of the Ph.D. study of Bea Nielsen. WP5+6+8 form part of the Ph. D. study of Helena Mejer in collaboration with the DARCOF II project MANORPIG.

M.Sc. student Diana Thomsen (agr.) is associated with WP3 and M.Sc. student Christina Guldborg Hansen (biol.) is associated with WP5 and WP6 in 2001 and part of 2002.

8G. National and international co-operation

An EU-application (Worm control in organic production systems for small ruminants - WORMCOPS) with participation of SMT (coordinator) and KB was approved early in 2001. Many activities are overlapping and a high level of synergy is expected.

8H. Possible elaboration of project and achieved results