Danish Research Centre for Organic Farming

Midterm Status Report 2003 and Application for Continuation in 2004

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

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1. Research program

Research in organic farming 2000-2005 (DARCOF II)

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2. Project title and number

I.8 Management of perennial weed species in organic farming (MPW) FØJOII

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3. Head of project

Senior scientist Bo Melander (BME), Department of Crop Protection, DIAS

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4. Participating institutes

Danish Institute of Agricultural Sciences (DIAS)

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5. Other project staff

Scientist, Ph.d. Enrico Graglia (ENG), Department of Crop Protection, DIAS

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6. Project period (month, year)

Start of project:	2000
End of project:	2004

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7. Midterm description of the project, its results and progress, and application for continuation in 2004

A. Project summary

Introduction
Research on perennial weed species in organic cropping systems is quite limited, although these species are becoming an increasing problem, especially on diary farms with high percentage of clover grass and in stockless cropping systems where cereals are dominating. Common mechanical control methods against annual weeds, such as weed harrowing and hoeing, only have limited effect on perennials because they only cause little damage to the root systems. Most perennials will easily regenerate from their roots and rhizomes that normally are placed deeper in the soil than the working depth of the implements.

Research on weed ecology and population dynamics of perennials will augment the current knowledge, and in combination with strategic experiments with non-chemical weed control methods, it will contribute to the development of novel and preventive weed management of perennials. This project focuses on *Cirsium arvense* (L.) Scop. and *Elymus repens* (L.) Gould because they have been identified as the main perennial weed species in organic crop rotations in Denmark both in terms of incidence and economic importance.

State of the art
Research on competition of *C. arvense* is limited and only carried out in conventional farming systems. However, different length and vertical placement of root fragments in the soil are known to have significant effect on the vegetative regeneration. Also, suppression of *C. arvense* can be significant when thistle-stems are cut in a crop that re-grows quickly and possesses a strong suppressive ability. However, there have been no attempts to include this information into more strategic research aiming at merging the benefits of root and stem cutting with the suppressing ability of a plant cover, e.g. crop or catch crop.

Knowledge about the temporal and spatial dispersal of *C. arvense* patches can improve the understanding about the population dynamics of the species and lead to better management systems. So far, only few studies on the spatial and temporal processes of spread and establishment of *C. arvense* have been made in the USA and the Netherlands. No descriptive study has ever been made for *C. arvense* under Danish climate conditions. This information seems valuable, not only for comparison with findings at other locations, but also valuable to Danish farmers in general.

Deep soil tillage conducted in the post-harvest period might be an efficient method of controlling *C. arvense*. The effect will, however, depend on the timing and length of the tillage period and the presence of dormancy in *C. arvense*. Yet, post-harvest tillage is often omitted in organic farming because plants mostly cover the soil in that period, e.g. catch/cover crop, autumn-sown crops or perennial crops. Crop cover in the autumn is desirable in organic farming, owing to the need for retaining nitrogen in the cropping systems, and consequently opportunities for post-harvest tillage become limited.
Preliminary results from the ongoing crop rotation experiments in DARCOFI have shown surprisingly lower densities of *C. arvense* in the crop-rotation systems where catch crops are grown, even in the absence of post-harvest tillage. However, the hypothesis that catch crops can suppress *C. arvense* infestations needs to be studied more thoroughly. If the hypothesis is valid, a preventive strategy using catch crops can be developed.

The main control method for *Elymus repens* in organic cropping is stubble cultivation between harvest and ploughing, the post-harvest period. However, this method becomes more difficult to conduct because organic growers prefer to keep the soil covered with plants in most of the post-harvest period to retain nutrients in the upper soil horizons as mentioned for *C. arvense*. Experiments have indicated that a short period of intensive post-harvest cultivation of the soil, followed by the growing of a competitive catch crop, and finally deep ploughing in the autumn, can reduce *E. repens* infestations, even in crop rotations dominated by cereals. Thus, it seems that a short duration of post-harvest soil cultivation, followed by catch crop growing, could be combined to suppress *E. repens* infestations to tolerable levels and still meet the need for nutrients. However, several aspects need to be further studied in order to clarify the potential of this hypothesis. Aspects such as: the intensity of post-harvest soil cultivation needed for rhizome disintegration, the period soil cultivation have to take place, the competitiveness of different catch crops to suppress shoot growth, and the influence of final deep burial of exhausted rhizome pieces. More information on these aspects could lead to better solutions for practical management of *E. repens*.

Work content

This project is focussing on important aspects of the ecology of *C. arvense*: competitive ability against different crops; spread and dispersal of thistle patches; and impact of stem and root cutting on the regenerative capacity of *C. arvense*. Research on these aspects will add valuable information to the economic importance of *C. arvense* infestations in organic crops, the suppressive ability of crops and catch crops, the development of thistle patches in different crop rotations, and the perspectives for stem or root cutting tactics against *C. arvense*. In addition, this will improve the fundamental knowledge of making more precise and effective management strategies against thistles. Regarding *E. repens*, an integrated control strategy, aiming at combining rhizome disintegration by soil cultivation in the post-harvest period, with later catch crop growing to suppress shoot growth, will be studied on sandy soils. Results from these experiments are expected to add new angles to the management of *E. repens*.

The project is organised in four work packages as listed in Table A.1

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

No.	Work package title	Participants*	Budget (1.000 DKr)	Start	End	Deliverable No:
1	The regenerative capacity and competitive ability of *C. arvense* following different periods of shoot growth inhibition in spring	ENG BME	592	2000	2004	WP1D1- WP1D2- WP1D3
2	The regenerative capacity and competitive ability of *C. arvense* following different periods of shoot growth inhibition in the late summer and autumn	ENG BME	475	2000	2004	WP2D1- WP2D2- WP2D3
3	Annual dispersal rate of *C. arvense* in a 4-year period under the influence of different levels of competition	ENG BME	506	2000	2004	WP3D1- WP3D2- WP3D3
4	Integrated control of *E. repens*	BME ENG	777	2001	2004	WP4D1- WP4D2- WP4D3

* Responsible participants are underlined

Short description of each work package.

All experiments in the four work packages (WP 1-4) are conducted as randomised factorial block experiments on:

1) an organic field (sandy loam) at the Technical College in Slagelse for WP 1 and 2, heavily infested with *C. arvense* and organically cropped for the last 15 years.
2) a conventional field (sandy loam) at Research Centre Flakkebjerg for WP3, with no presence of *C. arvense*. The experimental area is cropped according to organic principles in the experimental period.
3) an organic field (sand) at Jyndevad Research Station under DIAS for WP 4.

WP1

The major objective is to study the regenerative capacity and competitive ability of *C. arvense* following different periods of shoot growth inhibition by repeated hoeing in red clover or mowing in a grass clover mixture in spring and early summer.

Four field experiments have been established in spring barley, two experiments with and without undersown red clover (established in 2001 and 2002) and two experiments with and without undersown grass clover mixture (established in 2000 and 2001). Shoot growth of *C. arvense* is inhibited by hoeing in a row-sown red clover and by mowing in grass clover mixture: the hoeing and the mowing take place each time the thistle shoots are at their two-leaf stages, and the treatments are stopped either at 1 June, 1 July, and 1 August. These stoppages of thistle growth are done in plots with and without the clover crop to study the effect of crop suppression against the thistle in combination with the growth inhibition (the differences in length of the treatment period) by hoeing or mowing. The regenerative capacity and competitive ability of thistle will be assessed in a spring barley crop the following year as a result of treatments on different periods of growth inhibition in plots with and without red clover or grass clover mixture.

WP2

The major objective is to study the regenerative capacity and competitive ability of *C. arvense* following different periods of shoot growth inhibition (by repeated post-harvest cultivations or repeated mowing of an undersown catch crop) after different harvest times of a whole crop.

Two experiments have been established, one in 2001 and one in 2002. Two factors are under investigation:

Factor 1. Catch/cover crop (grass-clover mixture) undersown in the whole crop (barley-pea mixture, 1:1), two levels:

a. with
b. without

Factor 2. Harvest time of the whole crop, three levels:

a. 10 June (very early)
b. 1 July (normal)
c. 20 July (late normal)

The plots without undersown grass clover are repeatedly stubble-cultivated after harvest until 1 October while those with an undersown grass clover are mowed each time the thistle shoots has developed two true leaves after harvest.

The thistle response to the two factors is investigated, like WP1, in a subsequent

spring barley crop the year after the treatments by assessing the thistle growth.

WP3
The major objective is to study the growth, spread, and dispersion rate of thistle patches over a period of four years at two levels of crop competition.

Root fragments of *C. arvense* have been buried in the autumn 2000 after ploughing the experimental area. Shoot emergence from the fragments were arranged to take place at two levels of crop competition, one in spring barley and one in grass clover mowed regularly. The spatial distribution of shoot emergence is measured over time in a period of 4 years.

WP4
The major objective is to study and evaluate an integrated strategy based on mechanical disintegration of *E. repens* rhizomes followed by catch crop growing to control *E. repens* infestations

Stands of *E. repens* have been established in the spring of 2001 and 2002, respectively, to give two experiments by sowing seeds of *E. repens* in a wide-spaced spring barley crop. In the autumn 2001/2002, aboveground vegetation is mowed and removed, and the experimental area is ploughed. Spring barley is then sown in the spring of 2002/2003 and just after harvest in August, the experimental area is divided into plots according to the experimental factors under consideration. They were:

Factor 1) mechanical disintegration of rhizomes, five levels:
a. untreated
b. disintegration and loosening by ploughing to only 10 cm soil depth
c. strong disintegration by rotary cultivation
d. disintegration and loosening by stubble cultivation
e. loosening and uprooting by a newly developed Danish implement, the *"Kvik-Up"*, that is based on a cutting and digging tool element and a rotating tool element for uprooting.

Factor 2) catch crop growing, three levels:
a. no catch crop
b. fodder radish (*Raphanus sativus*)
c. mixture of red clover and rye grass

Factor 3) timing of ploughing, two levels:
a. late autumn
b. spring.

E. repens responses to the treatments are assessed the following year, 2003/2004, in spring barley sown on the experimental area.

B. Objectives and expected achievements

The objective of the project is to augment the knowledge about crop-weed competition, population dynamics, and mechanical control of the two main perennial weed species *Cirsium arvense* (L.) Scop. and *Elymus repens* (L.) Gould in organic farming. The knowledge can be integrated in weed management systems for these species, e.g.

- using catch crops to deplete and compete for nutrients, light, and water
- strategic control of thistle patches

- hampering the growth and regenerative capacity by stem or root cutting tactics
- cultivation tactics to eradicate or weaken the regenerative capacity of roots and rhizomes.

C. Midterm results and progress

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

WP1

The experiment, which focuses on effects of repeated mowing, has been completed successfully. The data from the current growing season will be finally analysed during autumn 2003. Results from 2002, clearly demonstrated a strong and significant effect of repeated moving. Compared to no mowing, repeated moving until mid July, decreased the biomass of *C. arvense* with app. 80% (fig. 1a) and consequently increased yield of spring barley with app. 50% (fig. 1b). The intermediate periods of mowing, until mid May and mid June, had no effect on biomass of *C. arvense* or yield, when compared to no moving. Furthermore the presence of grass-clover seems not to affect the growth of *C. arvense*.

The experiment concerning effects of repeated hoeing will run for another year. Data from the current growing season will be analysed during autumn 2003.

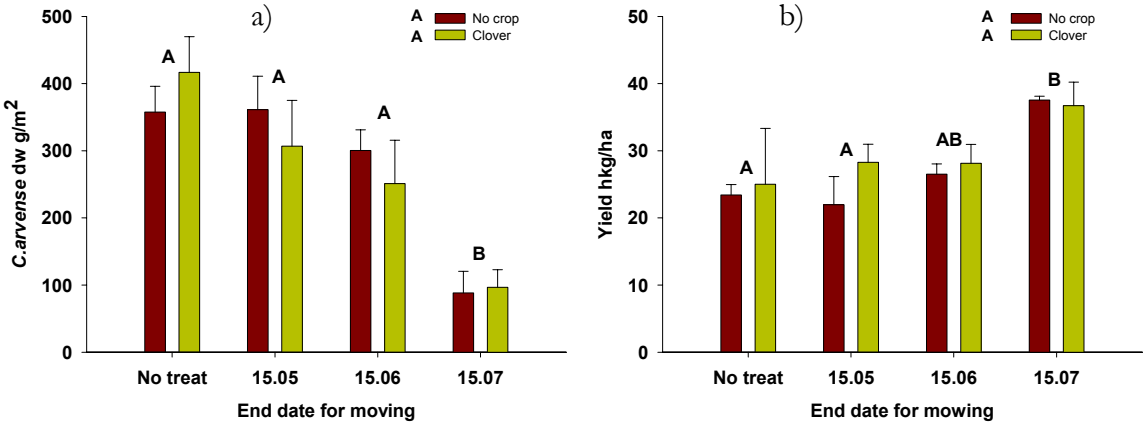

Figure 1. Effects of repeated mowing in a clover-grass mixture/crop-free situation on the growth of *C. arvense* a) and spring barley b) the subsequent year. Means of biomass of *C. arvense* and yield of spring barley with standard errors. Mean bars with different letters are different at a 0.05 significance level. The two different crop situations had no effect on yield or biomass of *C. arvense*.

WP2

Both experiments with post-harvest treatments have been completed successfully. Data from the current growing season will be analysed during autumn 2003. Results from the 2002 growing season show that the growth of *C. arvense* was affected by post-harvest treatments, particularly when the whole crop harvest was carried out early in the season. The early harvest, 10 June, and the subsequently greater number of post-harvest treatment, decreased the biomass of C. arvense with app. 85%, when compared to the late harvest (fig 2a). However, this very strong effect was not followed by a similar increase in yield (fig 2b). The main reason for this is most likely, that the infestation of *C. arvense* did not attain a yield reducing level in neither of the plots. In contrast, the presence of a clover grass catch crop had no effect on the growth of *C. arvense*, whereas the yield of spring barley increased with app. 25%. Hence, while the catch crop increased the yield, proba-

bly as a result of an increased N availability, the catch crop had no depleting effect on *C. arvense*.

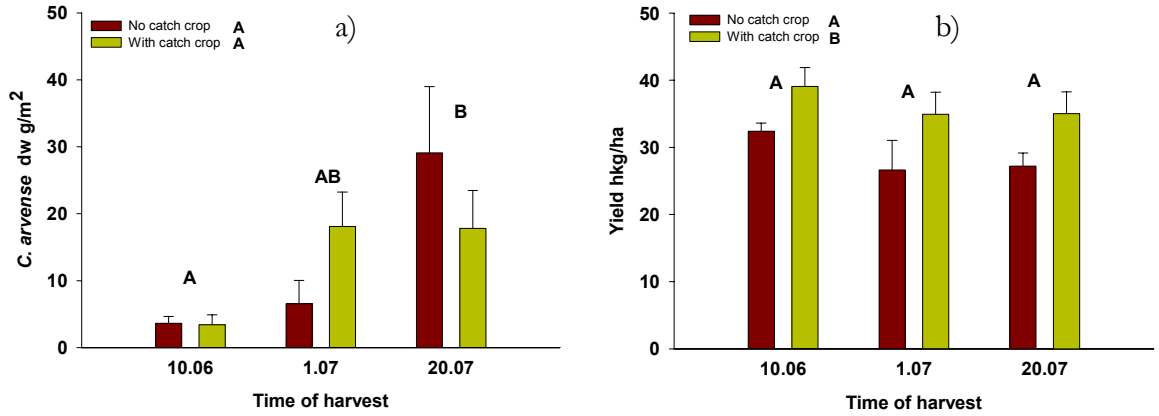

Figure 2. Effects of different harvest times of whole crop (barley-pea) followed by repeated post-harvest cultivations or repeated mowing of a catch crop (clover-grass mixture) on the growth of *C. arvense* a) and spring barley b) the subsequent year. Means of biomass of *C. arvense* and yield of spring barley with standard errors. Mean bars with different letters are different at a 0.05 significance level. The presence of a catch crop increased the yield of spring barley, whereas it had no effect on the biomass of *C. arvense*.

WP3

As mentioned in midterm status report 2002, the growth of below ground *C. arvense* was higher than expected. For this reason it was no longer possible to relate the above ground shoots to the buried root fragments from which they originated. Hence, treatment mediated differences in the spatial distribution would no longer be obtainable, why the experiment has been terminated. It is not likely that data will hold for an international peer reviewed paper as originally planned. However, data already obtained will be compared to data from similar studies and published in an agricultural journal.

WP4

In the first experiment (*E. repens* stand established in 2001), stubble cultivations were successfully conducted in 2002 according to factor 1 as described above under WP4 under work content. However, catch/cover crops (factor 2) developed poorly in the autumn 2002 due to dry and warm weather. This year, spring barley has been grown and *E. repens* aboveground biomass production been assessed near harvest time. Barley grain yield was obtained by plot wise combining and the first brief results are summarised in Figure 3.

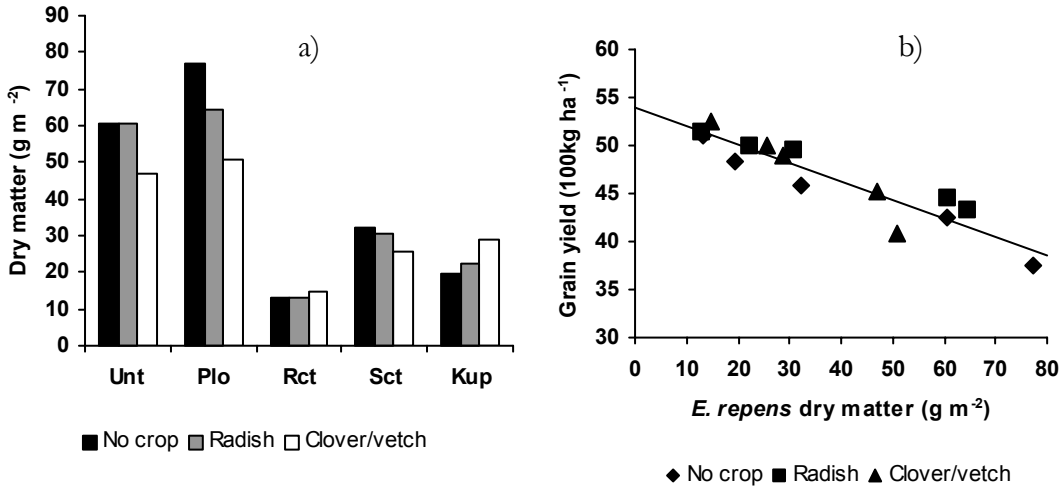

Figure 3. Effects on aboveground *E. repens* biomass a) of previous year's post harvest stubble cultivation (untreated (Unt), shallow

stubble cultivation (Plo), p.t.o. driven rotary cultivation (Rct), tine cultivation (Sct) and "Kvik-Up" cultivation (Kup)) and catch/cover crop growing. Barley yield b) plotted against aboveground *E. repens* biomass near to harvest following previous year's stubble cultivation and catch/cover crop growing.

Particularly rotary cultivation (Rct) had lowered *E. repens* infestation considerably, whereas shallow ploughing (Plo) surprisingly had no effect. The catch/cover crops only suppressed *E. repens* growth relatively weakly in autumn 2002, although *E. repens* growth also suffered from the dry spell. However, apparently the clover/vetch mixture had an effect on *E. repens* in the subsequent year where *E. repens* infestation was still high. The N-fixating ability of the legumes has probably enhanced vegetative barley growth and thus the suppression of *E. repens*. Figure 3b shows that barley grain yields were closely related to the success of *E. repens* control. Ploughing autumn or spring (factor 3) had no influence on the results. More data have been collected from the experiment and they will be presented in coming papers along those presented here.

The second experiment was started in the spring 2002 and a dense *E. repens* stand developed. Spring barley was grown this year and stubble cultivation and establishment of catch/cover crop were conducted as planned after harvest in early August 2003. Spring barley will be grown in 2004 and the treatment effects will be assessed around harvest time. All other assessments will follow those made in the first experiment to achieve two years results for appropriate comparisons between years.

C.2 Fulfilment of deliverables and milestones

(To be completed for each work package)

WP 1. The regenerative capacity and competitive ability of *C. arvense* following different periods of shoot growth inhibition in spring	Time schedule according to application	Deviations, if any
Task		
1. Planning, design, and establishment of field experiments	April 2001 and April 2002	
2. Measurement of shoot emergence	Sept 2001 and Sept 2002	
3. Regression and time series analysis		
Deliverables		
1. Annual progress reports	Oct 2001 and Oct 2002	
2. Scientific contribution on the effect of cutting of *C. arvense* in national or international conferences/workshops	Jan 2004	
3. Scientific contribution on the regenerative capacity of *C. arvense* following different periods of shoot growth inhibition in spring in a peer-reviewed journal	Ultimo 2004	
Milestones		
1. Experimental design and protocol	Jan 2001 and Jan 2002	
2. Establishment of field experiments	April 2001 and April 2002	
3. Conducting and finalising the shoot growth inhibition and data capture	Aug 2001 and Aug 2002	
4. Choice of regression and time series models		

WP 2. Shoot emergence pattern and competitive ability of *C. arvense* following different periods of shoot growth inhibition in autumn	Time schedule according to application	Deviations, if any
Task		
1. Planning, design, and establishment of field experiment	April 2001 and April 2002	
2. Measurement of shoot emergence	Sept 2001 and Sept 2002	
3. Regression and time series analysis		
Deliverables		
1. Annual progress reports	Oct 2001 and Oct 2002	

2. Scientific contribution on the effect of post-harvest tilling of *C. arvense* in national or international conferences/workshops	Jan 2004	
3. Scientific contribution on the regenerative capacity of *C. arvense* following different periods of shoot growth inhibition in autumn in a peer-reviewed journal	Ultimo 2004	
Milestones		
1. Experimental design and protocol	Jan 2001 and Jan 2002	
2. Establishment of field experiment	April 2001 and April 2002	
3. Conducting and finalising the shoot growth inhibition and data capture	Oct 2001 and Oct 2002	
4. Choice of regression and time series model		

WP 3. Annual dispersal rate of *C. arvense* in a 4-year period under the influence of different levels of competition	Time schedule according to application	Deviations, if any
Task		
1. Planning, design, and establishment of field experiment	April 2001 and April 2002	
2. Annual temporal and spatial measurements	Sept 2001 and Sept 2002	
3. Regression and time series analysis		
Deliverables		
1. Annual progress reports	Oct 2001 and Oct 2002	
2. Scientific contribution on the spatial and temporal dispersal of *C. arvense* in national or international conferences/workshops	Cancelled	Data published in agr. journal
3. Scientific contribution on the annual dispersal rate of *C. arvense* in a 4-year period under the influence of different levels of competition in a peer-reviewed journal	Cancelled	Data published in agr. journal
Milestones		
1. Experimental design and protocol	Sept 2000	
2. Achievement of *C. arvense* in a regular grid	Sept 2000	
3. Conducting and finalising the crop sequence and data capture	Sept 2001 and Sept 2002	
4. Choice of regression and time series model		

WP 4. Integrated control of *Elymus repens*	Time schedule according to application	Deviations, if any
Task		
1. Planning, design, and establishment of field experiments	April 2001 and April 2002	
2. Conduction of field experiments and data capture	Aug 2001	
3. Data analysis and publishing	2004	
Deliverables		
1. Annual progress reports	Oct 2001and Oct 2002	
2. Scientific contributions in national or international conferences/workshops	Ultimo 2004	
3. Scientific contribution in a peer-reviewed international journal drafted	Ultimo 2004	
Milestones		
1. Experimental design and protocol	April 2001	
2. Achievements on rhizome disintegration and distribution in the soil profile of first and second experiments	Aug 2002	
3. Achievements on catch crop suppression of *E. repens* in first and second experiments	Oct 2002	
4. Achievements on the final control of *E. repens* following the integrated strategy in first and second experiments	Ultimo 2004	
5. Final choice of statistical approach to describe data		

C. Description of deviations and subsequent adjustments of plans

PhD student *Rikke Klith Jensen* decided to stop her PhD study in January 2003 and shortly afterwards she resigned from the Danish Institute of Agricultural Sciences for personal reasons. Consequently, all PhD-activities associated with the project have been cancelled while tasks formerly discharged by *Rikke K. Jensen* in the project have now been handed over to scientist and PhD *Enrico Graglia*. All project plans will be continued and milestones and deliverables will be accomplished as outlined under C.2.

E. Project publications and other products

1. Articles in international, scientific journals with review procedures

Hatcher P.E. & Melander B. (2003). Combining physical, cultural and biological methods: prospects for integrated non-chemical weed management strategies. *Weed Research, 43(5), 303-322.*

2. Papers presented at congresses, symposiums, etc.

11-13 March 2002, EWRS workshop on Physical Weed Control in Pisa (Italy). Poster presentation of a degree-day model of Cirsium arvense predicting shoot emergence from root buds. *Rikke Klith Jensen, David Archer & Frank Forcella.*

March 2003. Poster presentation 20. Danske Planteværnskonference. DJF rapport - Markbrug 89, 357-358. Har agertidsel og ager-svinemælk skudhvile?. *Henrik Grøndal, Enrico Graglia & Rikke Klith Jensen.*

July 2003. 22. NJF Congress, Turku, Finland. Fogelfors, H., Brandsæter, L. O., Graglia, E., Vanhala, P., Salonen, J. & Håkansson, S. Dormancy of vegetative reproduction in some perennial weeds.

3. Reports, articles in agricultural journals, etc.

December 2002. Hårde betingelser for Vestaustraliens økologer. Økologisk Jordbrug 27 december 2002, side 4. *Bo Melander*

June 2003, JordbrugsNyt. Succesfuld bekæmpelse af tidsler – uden kemi. *Enrico Graglia*

June 2003, Økologisk Jordbrug. Tidslerne får det glatte lag. Økologisk Jordbrug. *Enrico Graglia & Bo Melander*

August 2003, LandbrugsAvisen. Ager-Tidsel kan bekæmpes uden kemi. *Enrico Graglia*

September 2003, Familielandbruget Aktuel Økologi. Bekæmpelse af Ager-Tidsel i sædskiftet. *Enrico Graglia.*

4. Oral presentations, public meetings, field days, etc.

2 Feb 2001, first meeting in the Nordic NJF-group (Sweden) Coming Danish activities and experiments with *C. arvense* and *E. repens,* including current knowledge about the management of those two species in organic cropping in Denmark. Presented by *Rikke Klith Jensen* and *Bo Melander*.

25 Sept 2001, - Presentation on modelling shoot emergence of Canada thistle at the University of Minnesota, St Paul, Department of Agronomy and Plant Genetics, USA, presented by *Rikke Klith Jensen*.

3-4 Feb 2002, second meeting in the Nordic NJF-group (Denmark) Modeling shoot emergence of *Cirsium arvense* based on soil temperature, by *Rikke Klith Jensen* and 2) A new implement for mechanical control of perennials, by *Bo Melander*.

28-31 Feb 2002, – Four meetings were arranged by the Danish Agricultural Advisory Centre in Aarhus for advisers, teachers, and employers of agricultural trade organisations in four different cities in Denmark. *Rikke Klith Jensen* gave, at each of the four meetings, an oral presentation on the biology and control of *C. arvense*.

14 Aug 2002, – Oral presentation of the shoot emergence dynamics of Canada thistle at the North Central Soil Conservation Research Lab Field Day at Swan Lake Research Farm, Minnesota, USA, presented by *Rikke Klith Jensen*.

8 Sep – 12 Oct 2002. Bo Melander visited Australia and New Zealand (based on an invitation) and gave 16 seminars on various subjects of weed control in organic farming and farming systems aiming at reducing herbicide dependence. Also more general information about the development of organic farming in Denmark and the Danish pesticide policy was given to the audiences that included researchers, advisors, farmers and authorities.

2-3 Feb 2003, third meeting in the Nordic NJF-group (Norway) Danish results from joint experiment on dormancy in *C. arvense* and *Sonchus arvensis*. Presented by *Enrico Graglia*.

10 April 2003, - oral presentation on the importance of crop competition in physical and cultural weed control strategies. Presented by Bo Melander at the EWRS-workshop on cop/weed interaction held in Viterbo, Italy.

F. Scientific education

None

G. National and international cooperation

A Nordic working group with participants from four Nordic countries, Finland, Norway, Sweden, and Denmark, has been established as a NJF working group. The group is dealing with issues on the management of perennial weeds, particularly in organic farming. A joint experiment studying the dormancy of *C. arvense* and *Sonchus arvensis* in late summer and autumn was started in

spring 2002. A third meeting was held in Norway February 2003. The main objective for this meeting was to present and discuss the results from the joint experiment. The result of the joint experiment has been presented at NJF Congress, Turku Finland, in June 2003.

H. Critical reflection on the project

Because of the rapid growth of *C. arvense* roots, special attention should be paid to experimental designs as used in WP3, when trying to elucidate any kind of long term treatment effects on *C. arvense*. Given the growth capacity of *C. arvense*, the aerial parts in a given plot may or may not originate from roots within the plot. Hence, only vague conclusions, about the relationship between experimental treatments and long-term dispersal rate and growth capacity, could be drawn.

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:	Consump-tion before 2000	2000	2001	2002	2003	2004	Total
Man-months							
Scientific personnel		4	10	9	9	10	42
Technical personnel		3	5	6	6	1	21

Year:	Consump-tion before 2000	2000	2001	2002	2003	2004	Total
Salaries							
Scientific personnel		97	273	260	273	334	1.237
Technical personnel		55	96	122	128	23	424
Other operational costs		12	59	73	73	15	232
Equipment		15	50				65
Others (please specify)							
Direct costs							
Indirect costs (20% of direct costs)		36	96	91	95	74	392
Total		215	574	546	569	446	2.350

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project Senior scientist Bo Melander	Danish Institute of Agricultural Sciences, Department of Crop Protection, Research Centre Flakkebjerg	30 September	