



Danish Research Centre for Organic Farming



Application

for research funding under the research programme:

Research in Organic Food and Farming

International Research Co-operation and Organic Integrity

(DARCOF III 2005-2011)

Funded by the Ministry of Food, Agriculture and Fisheries
under the Finance and Appropriation Act, Sections 24.33.02.10

Application deadline 15th March 2005 at 12:00 a.m.

1. **Project title and acronym:**

Effective control of perennial weeds and intra-row weeds in organic cropping through novel technology and new management strategies

WEEDS

2. **Project manager:**

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3. The project is within the following research project theme:

The proposal falls within "3.3.2 Intelligent ukrudtsregulering" under "3.3 Udvikling og effektivisering af økologisk primærproduktion" in the calls for proposals.

The proposal does not include precision sowing technology because the technology suggested for automation of intra-row weed control in the application does not depend on precision sowing technology.

4. Participating institute(s):

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7. **Project duration:** 5 years From: Jan. 2007 To: Dec. 2011

8. **Main objective(s):**

1. Long-term objective

Knowledge on how to manage perennial and intra-row weeds effectively by means of novel strategies and technology is available to organic farmers.

2. Project objectives

1. Effective management strategies for *Cirsium arvense* (L.) Scop. and *Tussilago farfara* L., involving both preventive and direct control measures, have been developed and communicated to organic farmers.
2. Novel technology for exposing and destroying *Elymus repens* (L.) Gould rhizomes and *Rumex crispus* L. rootstocks has been developed and for *E. repens* validated in an organic cropping system context.
3. Weeding robot that operates in vegetable crops and physically destroys weeds in the rows has been developed.
4. Punch planting techniques and its strategic use with stale seedbed and physical intra-row weeding has been developed and validated in close collaboration with objective 3.
5. Strategies for the integrated control of two perennial species (*C. arvense*, *T. farfara*) and major annual weed species have been formulated, based on a weed population dynamics model, and communicated to organic farmers.

9. **Project summary in Danish:**

I økologisk planteproduktion er der stadig betydelige problemer med rod ukrudt generelt og med enårigt ukrudt i rækken i rækkeafgrøder specifikt. For rod ukrudtets

vedkommende er det især arterne alm. kvik (*Elymus repens* (L.) Gould), ager-tidsel (*Cirsium arvense* L. Scop), kruset skræppe (*Rumex crispus* L.) og følfod (*Tussilago farfara* L.), der volder vanskeligheder i mange sædskiftetyper. Traditionelt bekæmpes rodukruddt ved gentagne jordbearbejdnings i efteråret, men denne strategi er uønsket i økologisk jordbrug grundet ønsket om at holde jorden plantedækket længst muligt af hensyn til næringsstofhusholdningen. Problemet med ukrudt i rækken i rækkeafgrøder, hvilket primært er grønsagskulturer, skal først og fremmest findes i det store tidsforbrug til håndlugning, som mange avlere stadig anvender for at renholde deres rækkeafgrøder.

Under FØJOII undersøgte flere strategier til regulering af ager-tidsel. Denne forskningsindsats inkluderede ikke følfod, hvor der for nuværende ikke eksisterer videnskabelig viden om effektive, ikke-kemiske bekæmpelsesmuligheder. Strategierne mod ager-tidsel klarlagde et betydeligt potentiale for effektivt at kunne bekæmpe denne art over en forholdsvis kort periode. Bekæmpelsesindsatsen var dog ganske intensiv og ikke umiddelbart attraktiv for praksis. Der viste sig et behov for bedre at kunne time indsatsen, således at antallet af behandlinger kan nedsættes. Derfor vil vi i nærværende forskningsindsats søge at opnå en bedre og mere grundlæggende forståelse af biologien hos både ager-tidsel og følfod med særlig vægt på planternes allokering af kulhydrater til de underjordiske regenerative organer - rødder hos ager-tidsel og rhizomer hos følfod. En målrettet svækkelse af disse vil effektivt kunne svække planternes udviklingsmuligheder. Der satses på en tostrengt forskningsindsats begyndende med grundlæggende undersøgelser i klimakamre og væksthuse af arternes kulhydratallokering under indvirkning af forskellige afbrydelser af væksten, eksempelvis gentagne afhugninger af den overjordiske biomasse. Dernæst søges arbejdet valideret og udbygget gennem kontrollerede semifield- og markforsøg for til sidst at ende op med forslag til rationelle bekæmpelsesstrategier, der tager udgangspunkt i en optimal svækkelse af arternes regenerationsevne.

Foruden at forbedre bekæmpelsen af ager-tidsel og følfod vil projektet også søge at tilvejebringe viden og teknologi til en effektiv og rationel bekæmpelse af alm. kvik og kruset skræppe. I modsætning til de to øvrige rodukruddtsarter har kvik og skræppe meget overligt placerede henholdsvis rhizomer og jordstængler. Nyudviklet redskabsteknologi vurderes at kunne blotlægge rhizomerne og jordstænglerne fuldstændigt på jordoverfladen. De blotlagte rhizomer og jordstængler tænkes derefter destrueret gennem tilpasset teknologi. Eksempelvis kan et større kvikproblem således hurtigt og effektivt blive bekæmpet uden behov for gentagne jordbearbejdnings over længere perioder.

I tidligere FØJO-finansierede forskningsprojekter er der arbejdet med flere mekaniske og termiske metoder til fjernelse af ukrudt i rækken. Et væsentligt problem ved disse metoder er, at de ikke opererer selektivt, hvorved også afgrødeplanterne rammes. Stribedampning er ganske vist et nyt og meget lovende bekæmpelsesprincip udviklet under FØJOII, men metoden er kontroversiel i forhold til de økologiske dyrkningsprincipper. Derfor vil vi i dette projekt udvikle en teknologi, som selektivt kan fjerne ukrudt i rækken og ikke er i modstrid med de økologiske dyrkningsprincipper. I flere forskellige udenlandske forskningsmiljøer er der arbejdet intensivt med højteknologier, som på sigt kan føre til egentlige lugerobotter som ubemandet, automatisk og selektivt kan fjerne ukrudt i rækken. De mest perspektivrige teknologier mangler dog stadig at blive integreret til en operationel enhed. Denne integration vil blive foretaget i nærværende projekt og valideret i forhold til forskellige bekæmpelsscenarioer i både udplantede og punktsåede grønsagskulturer. Punktsåning (punch planting) er en ny

såteknik, som kan reducere og forsinke ukrudts fremspring. Ved denne metode trykkes frøene ned i jorden uden nogen forudgående såbedstilberedning, og lige før afgrødens fremspiring kan ukrudtet bekæmpes med flammebehandling. I projektet vil det også blive undersøgt om punktsåning med fordel kan kombineres med falske såbedsstrategier mhb. at fremme afgrødens konkurrenceevne samt selektivitetsforholdene ved fysisk ukrudtsbekæmpelse i rækken.

Ukrudtsproblemer i økologisk jordbrug skal altid vurderes i en større dyrknings- og sædskiftemæssig sammenhæng. Derfor vil den generede viden i projektet blive integreret i et igangværende arbejde med en model til simulering af ukrudtets udvikling i økologiske og konventionelle sædskifter under indflydelse af diverse handlinger. Herved vil det blive muligt bedre at kunne vurdere, hvilken betydning de opnåede resultater vil have ud fra en helhedsmæssig betragtning omfattende sædskifte og øvrige ukrudtsarter.

10. Budget:

The proposed budget must be inclusive of increases in the level of salaries and prices and specified on an annual basis. The proposed budget must specify the number of man-months and related salary costs for scientific staff and non-scientific staff, other direct costs and costs to buy equipment. To this should be added an overhead contribution of 20% of the direct costs.

Salary levels must not exceed union levels for comparable positions in the Public Service (e.g. laboratory assistant, researcher or senior researcher).

Official journeys must follow government regulations.

The applicants are generally expected to procure and make available all necessary equipment for the project themselves. Only in exceptional cases when this is not possible may expenditures for the acquisition of equipment be included in the budget for consideration.

Funding is provided exclusive of the recipient's input VAT (purchase VAT) and output VAT (sales VAT).

For government institutes funding is provided in accordance with the budget guidelines issued by the Ministry of Finance for research activities receiving programme funding and the funding is only granted for one year at a time.

If private business partners co-finance or take part in the project otherwise then all partners have to enter a co-operation agreement or provide other kind of documentation of the co-operation cf. 'Invitation til projektansøgninger'.

Note that budgets must be made for the entire project as well as for each participating institution.

Budget for the entire project—broken down by calendar year							
Budget item		From Ministry of Food, Agriculture and Fisheries		From place of work		From other sources	
		Person months	DKK	Person months	DKK	Person months	DKK
1st calendar year 2007	Salaries/academic staff	46.1	1,920,414	1	55,000		
	Salaries/techn.-adm. staff	14.5	378,437	3	108,800		
	Equipment		45,200				
	Operational expenses		574,572				
	Others (please specify below)		22,000				
Total direct costs			2,940,623		163,800		
Overhead (20 % of direct costs)			588,124		32,760		
Total			3,528,747		196,560		
2nd calendar year 2008	Salaries/academic staff	46	1,728,631	2	111,872		
	Salaries/techn.-adm. staff	16	436,845	2	57,328		
	Equipment		25,000				
	Operational expenses		672,593				
	Others (please specify below)		22,880				
Total direct costs			2,885,949		169,200		
Overhead (20 % of direct costs)			577,190		33,840		
Total			3,463,139		203,040		
3rd calendar year 2009	Salaries/academic staff	34.55	1,417,604	2	114,160		
	Salaries/techn.-adm. staff	12	341,720	3.5	103,001		
	Equipment						
	Operational expenses		509,301				
	Others (please specify below)		23,795				
Total direct costs			2,292,420		217,161		
Overhead (20 % of direct costs)			458,484		43,432		
Total			2,750,905		260,593		
4th calendar year 2010	Salaries/academic staff	11.05	609,999				
	Salaries/techn.-adm. staff	7.7	228,752	2	60,000		
	Equipment		1000				
	Operational expenses		195,024				
	Others (please specify below)						
Total direct costs			1,034,775		60,000		
Overhead (20 % of direct costs)			206,955		12,000		
Total			1,241,730		72,000		
5th calendar year 2011	Salaries/academic staff	12.05	704,636				
	Salaries/techn.-adm. staff	1.5	46,000				
	Equipment						
	Operational expenses		95,597				
	Others (please specify below)						
Total direct costs			846,233				
Overhead (20 % of direct costs)			169,246				
Total			1,015,479				
Total for the 6 years			12,000,000		732,193		

Budget for each participating institution — Name of institution: Department of Integrated Pest Management DIAS						
Budget item	From Ministry of Food, Agriculture and Fisheries		From place of work		From other sources	
	Person months	DKK	Person months	DKK	Person months	DKK
2nd calendar year 2007	Salaries/academic staff	6.9	364,546			
	Salaries/techn.-adm. staff	4.5	122,00	1	27,000	
	Equipment					
	Operational expenses		125,000			
	Others (please specify below)					
Total direct costs		611,546		27,000		
Overhead (20 % of direct costs)		122,309		5,000		
Total		733,855		32,000		
3rd calendar year 2008	Salaries/academic staff	6.65	365,162			
	Salaries/techn.-adm. staff	6.5	182,000	1	28,000	
	Equipment		25,000			
	Operational expenses		182,500			
	Others (please specify below)					
Total direct costs		754,662		28,000		
Overhead (20 % of direct costs)		150,932		6,000		
Total		905,594		34,000		
4th calendar year 2009	Salaries/academic staff	8.15	454,887			
	Salaries/techn.-adm. staff	7	202,000	2.5	72,500	
	Equipment					
	Operational expenses		211,000			
	Others (please specify below)					
Total direct costs		867,887		72,500		
Overhead (20 % of direct costs)		173,577		14,500		
Total		1,041,464		87,000		
5th calendar year 2010	Salaries/academic staff	7.05	394,621			
	Salaries/techn.-adm. staff	5.5	164,000	2.0	60,000	
	Equipment					
	Operational expenses		153,333			
	Others (please specify below)					
Total direct costs		711,954		60,000		
Overhead (20 % of direct costs)		142,391		12,000		
Total		854,345		72,000		
5th calendar year 2011	Salaries/academic staff	11.65	678,676			
	Salaries/techn.-adm. staff	1.5	46,000			
	Equipment					
	Operational expenses		94,597			
	Others (please specify below)					
Total direct costs		819,273				
Overhead (20 % of direct costs)		163,855				
Total		983,128				
Total for the 6 years		4,518,386		225,000		

Operational expenses include payment to Jynde vad Research Station

Budget for each participating institution — Name of institution: Department of Agricultural Engineering DIAS						
Budget item	From Ministry of Food, Agriculture and Fisheries		From place of work		From other sources	
	Person months	DKK	Person months	DKK	Person months	DKK
1st calendar year 2007	Salaries/academic staff	25	1,100,368			
	Salaries/techn.-adm. staff	9	229,437			
	Equipment					
	Operational expenses		342,272			
	Others (please specify below)					
Total direct costs		1,672,077				
Overhead (20 % of direct costs)		334,415				
Total		2,006,492				
2nd calendar year 2008	Salaries/academic staff	20	756,029			
	Salaries/techn.-adm. staff	7.5	198,845			
	Equipment					
	Operational expenses		294,761			
	Others (please specify below)					
Total direct costs		1,249,636				
Overhead (20 % of direct costs)		249,927				
Total		1,499,563				
3rd calendar year 2009	Salaries/academic staff	7	325,850			
	Salaries/techn.-adm. staff	3	82,720			
	Equipment					
	Operational expenses		96,830			
	Others (please specify below)					
Total direct costs		505,400				
Overhead (20 % of direct costs)		101,080				
Total		606,480				
4th calendar year 2010	Salaries/academic staff	2	95,768			
	Salaries/techn.-adm. staff	2	57,352			
	Equipment					
	Operational expenses		38,101			
	Others (please specify below)					
Total direct costs		191,221				
Overhead (20 % of direct costs)		38,244				
Total		229,465				
Total for the 5 years		4,342,000				

Budget for each participating institution — Name of institution: Department of Genetics and Biotechnology DIAS			
Budget item	From Ministry of Food, Agriculture and Fisheries	From place of work	From other sources

		Person months	DKK	Person months	DKK	Person months	DKK
2nd calendar year 2007	Salaries/academic staff	0.94	46,000				
	Salaries/techn.-adm. staff						
	Equipment		1,000				
	Operational expenses				11,800		
	Others (please specify below)						
Total direct costs			47,000		11,800		
Overhead (20 % of direct costs)			9,400		2,360		
Total			56,400		14,160		
5th calendar year 2010	Salaries/academic staff	1	56,600				
	Salaries/techn.-adm. staff						
	Equipment		1,000				
	Operational expenses				14,500		
	Others (please specify below)						
Total direct costs			57,600		14,500		
Overhead (20 % of direct costs)			11,520		2,900		
Total			69,120		17,400		
Total for the 2 years			125,520		31,560		

		Person months	DKK	Person months	DKK	Person months	DKK
2nd calendar year 2007	Salaries/academic staff	1	44,200				
	Salaries/techn.-adm. staff	1	27,000	1	53,600		
	Equipment		44,200				
	Operational expenses		45,000				
	Others (please specify below)						
Total direct costs			160,400		53,600		
Overhead (20 % of direct costs)			32,080		10,720		
Total			192,480		64,320		
3rd calendar year 2008	Salaries/academic staff	7	227,700	1	54,672		
	Salaries/techn.-adm. staff	2	56,000				
	Equipment						
	Operational expenses		130,400				
	Others (please specify below)						
Total direct costs			414,100		54,672		
Overhead (20 % of direct costs)			82,820		10,934		
Total			496,920		65,606		
4th calendar year 2009	Salaries/academic staff	7	236,000	1	54,672		
	Salaries/techn.-adm. staff	2	57,000				
	Equipment						
	Operational expenses		132,500				
	Others (please specify below)						
Total direct costs			425,500		54,672		
Overhead (20 % of direct costs)			85,100		10,934		
Total			510,600		65,606		
5th calendar year 2010	Salaries/academic staff						
	Salaries/techn.-adm. staff						
	Equipment						
	Operational expenses						
	Others (please specify below)						
Total direct costs							
Overhead (20 % of direct costs)							
Total							
5th calendar year 2011	Salaries/academic staff						
	Salaries/techn.-adm. staff						
	Equipment						
	Operational expenses						
	Others (please specify below)						
Total direct costs							
Overhead (20 % of direct costs)							
Total			1,200,000		195,533		
Total for the 3years			1,200,000		195,533		

Budget for each participating institution — Name of institution: Danish Agricultural Advisory Service, National Centre, Crop Production

Budget item	From Ministry of Food, Agriculture and Fisheries	From place of work	From other sources
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		Person months	DKK	Person months	DKK	Person months	DKK
2nd calendar year 2007	Salaries/academic staff	0.3	17,300				
	Salaries/techn.-adm. staff	0	0				
	Equipment		0				
	Operational expenses		1,500				
	Others (please specify below)		0				
Total direct costs			18,800				
Overhead (20 % of direct costs)			3,760				
Total			22,560				
3rd calendar year 2008	Salaries/academic staff	0.3	17,820				
	Salaries/techn.-adm. staff	0	0				
	Equipment		0				
	Operational expenses		1,700				
	Others (please specify below)		0				
Total direct costs			19,520				
Overhead (20 % of direct costs)			3,904				
Total			23,424				
4th calendar year 2009	Salaries/academic staff	0.4	24,470				
	Salaries/techn.-adm. staff	0	0				
	Equipment		0				
	Operational expenses		3,210				
	Others (please specify below)		0				
Total direct costs			27,680				
Overhead (20 % of direct costs)			5,536				
Total			33,216				
5th calendar year 2010	Salaries/academic staff	1.0	63,010				
	Salaries/techn.-adm. staff	0.2	7,400				
	Equipment		0				
	Operational expenses		3,590				
	Others (please specify below)		0				
Total direct costs			74,000				
Overhead (20 % of direct costs)			14,800				
Total			88,800				
5th calendar year 2011	Salaries/academic staff	0.4	25,960				
	Salaries/techn.-adm. staff	0	0				
	Equipment		0				
	Operational expenses		1,000				
	Others (please specify below)		0				
Total direct costs			26,960				
Overhead (20 % of direct costs)			5,392				
Total			32,352				
Total for the 6 years			200,352				

11. Signatures:

Name	Institute	Date	Signature
Project manager: Bo Melander	Danish Institute of Agricultural Sciences, Department of Integrated Pest Management	30-11-2006	
Department management: Jørgen B. Jespersen	Danish Institute of Agricultural Sciences, Department of Integrated Pest Management	30-11-2006	
Department management: Svend Christensen	Danish Institute of Agricultural Sciences, Department of Agricultural Engineering	30-11-2006	
Department management: Christian Andreasen	The Royal Veterinary and Agricultural University, Department of Agricultural Sciences	30-11-2006	
Department management: John R. Porter	The Royal Veterinary and Agricultural University, Department of Agricultural Sciences	30-11-2006	
Department management: Henrik Callesen	Danish Institute of Agricultural Sciences, Department of Genetics and Biotechnology	30-11-2006	
Institute management: Carl Åge Petersen	Danish Agricultural Advisory Service, National Centre, Crop Production	30-11-2006	

Signature

Signature

Signature

Signature

Signature

12. **Description of the project:**

The description of the project must be given in Annex 1 and according to the guidelines described herein.

See Technical annex starting on page 25