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

1. Research program

Research in organic farming 2000-2005 (DARCOF II)

2. Project title and number

Band heating for intra-row weed control (I.9)

3. Head of project

Martin Heide Jørgensen
Head of research unit
Danish Institute of Agricultural Sciences
Dept. of Agricultural Engineering

4. Participating institutes

Danish Institute of Agricultural Sciences (DIAS)
The Royal Veterinary and Agricultural University (RVAU)

5. Other project staff

Erik Fløjgaard Kristensen, DIAS, Dept. of Agricultural Engineering.
Bo Melander, DIAS, Dept. of Crop Protection
Hans-Werner Griepentrog, RVAU, Agrotechnology

6. Project period (month, year)

Start of project: 04 2000
End of project: 12 2004

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

A. Project summary

The project aims at developing a new integrated machinery system for thermal soil treatment in a narrow band around the crop rows, with which the germination of weeds in between the crops can be limited effectively. Weed control of inter-row weeds can be achieved by means of precision hoeing, where a control system with an integrated vision sensor guides the implement automatically. The control system is basically developed by the research group at Bygholm and commercialised by "ECO-DAN". The possibility of combining the implement for thermal treatment with a system for precision sowing will be analysed.

In combination with the automatic hoeing system, the proposed system for thermal row treatment will provide effective elimination of the need for manual weeding in row cultivated crops, such as beets and vegetables. The recommended system will enable the farmers and the agricultural industry to meet the customers' demand for growing organic products.

At the present stage of the project a 1. generation of the prototype has been analysed and a optimised 2. generation (not planned in the list of deliverables) is under construction. The overall conclusion is, that the system can be used to give an effective in-row weed control under field conditions. The optimisation design criteria now is to minimise the energy consumption and the negative impact on the microbiological activity in the soil.

The energy consumption of the system is considerable, but in relation to the effect of in-row weed removal, it is acceptable. In the evaluation of the energy consumption it is important to have in mind, that many growers makes use of surface flaming in weed control. There are big variations in the energy consumption for this operation but a use corresponding to app 75 l oil per ha is quite normal. The flaming affects the weed such that the weeding activities are reduced by app 30%. Many growers spend app 100 manual hours per ha on weed control. The evaluation of the thermal band heating has to bee seen in this perspective.

The laboratory results of the band steaming process have shown that in order to obtain an effective weed effect, the soil would have to be heated to a temperature higher than 70°C. The lab tests showed, the system are able to give a close to 100% weed control by a energy input of 170 l oil per ha. The first field trials carried out in 2002 have shown that the maximum temperature would have to be increased to about 85-90°C to obtain an effective weed effect. This is mainly due to energy losses and poor seed-bed preparation. At 90°C, the energy con-

sumption will be about 300 l of oil/ha at a soil water content of 20%. It is the expectation, that the 2. prototype will have an improved performance in the field, so that the max temperature can be lowered to about 70°C, then the energy consumption can be lowered to approx. the 170 l of oil/ha as measured under lab conditions. The great deviation in fuel requirement is due to the fact that the losses is increasing dependently at increasing temperatures, even if a temperature of 100°C is not reached in any spot of the cross section witch would imply a dramatic energy loss due to evaporation of soil water.

The activities are organised in the following five work packages (WP):

1. Technical process analysis
2. Basic biological analysis (lab. test)
3. Establishment of prototype and technical field validation
4. Biological field validation
5. Precision sowing in treated bands and determination of seed positions

The timing of the activities is as follows: WP 1 & 2 has been carried out in close connection, and likewise are WP 3 & 4. The activities in WP 5 have been following their own plan. This WP has been aiming at developing a system for precision seeding within the treated bands. WP 5 also involves a system for geo-positioning of each individual seed in order to control the following operations very precisely. The results of this package can be used independently, but the WP also involves a potential future improvement of the steam system, where the band treatment could be developed into a spot treatment.

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

No.	Work package title	Participants*	Budget (1.000 DKK)	Start	End	Deliverable no(s):
1	Technical process analysis	MHJ, EFK	978	4/00	12/02	1a,1b
2	Basic biological analysis (lab. test)	BM, TH	990	4/00	12/04	2a,2b
3	Establishment of prototype and technical field validation	MHJ, EFK	1.246	1/01	12/04	3a,3b
4	Biological field validation	BM, TH	810	4/02	12/04	4a,4b
5	Precision sowing in treated bands and determination of seed positions	HWG	976	4/00	3/02	5a,5b

* Responsible participants are underlined

B. Objectives and expected achievements

The aim of the project is to develop a system for thermal soil treatment in close bands covering the crop rows. The system has to be optimised for minimum energy consumption and effective weed control in the intra-row area. In relation to the development of the system it is a high demand to respect the structure of the soil and its positive biological activity.

The objective will be achieved through the following activities:

- Establishment of a prototype of an implement that will permit the performance of thermal soil treatment in narrow bands covering the crop rows. The prototype will be a result of a detailed analysis of the thermal processes involved
- Establishment of basic biological knowledge for erasing the germination capacity of weed seeds in soil
- Realisation of the adaptation of precision sowing equipment to special demands involved with band treatment. Modification and investigation of particular tools to achieve good seed placements and good covering in treated bands. Determination of the position of each placed seed by means of high precision GPS. Utilisation of the position data to optimise the energy input on thermal soil treatment (spot treatment) and to allow a guidance of weeding tools between crop rows and plants in order to remove unwanted plants (inter and intra-row weeding).

C. Midterm results and progress

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

- The band steaming concept is evaluated in a serie of lab tests, where batches of soil are treated under controlled environment, where the heating process to the max temperature is controlled and likelyvise the cooling. Hereby series of equal treated batches is produced and tested for the germination capability of the content of weed seeds. The results shows, that under lab conditions the effect is better than 98% by heating to a temperature higher than 70 ^{o}C, and following a cooling procedure, where the temperature after 10 min is decreased app. 10 ^{o}C.

- A first generation field implement is designed and the analysed results from here show that it is possible to obtain results similar to what is seen in the lab, but the max. Process temperature has to be raised to app. 90 ^{o}C. To attain an effective weed control as described for the lab tests.

- The necessary energy consumption for a oil heated system with a normal efficiency is calculated and documented in the lab to about 170 l oil per ha (50 cm row spacing). The field tests with the 1. generation prototype shows an oil consumption of app. 300 l oil per ha mainly due to the higher temperature level. It is assumed, that a better efficiency can be obtained by design optimisation.

- A consultant has been hired to compose a cost benefit analyse. Results from here show an economical break-even by a production area of 4 ha with carrots or onions.

- Based on the experiences with the first prototype a second generation is designed and will be tested under simulated field conditions in the autumn 2003. Due to the promising economical perspective collaboration is established with the company Karl Oluf Madsen that is interested in taking over the rights for production and sales.

- The evolution of the process equipment has reached the technical design phase. The implementation of the system raises some questions concerning the environmental impact. Even the energy efficiency can be improved; the process still requires substantial energy consumption. This has to be ballanced against the benefits of the process. An-

other problem is the effect on the soil that is sterilize such that also the soil flora and fauna is killed in the treated band. This problem has been analysed in 2003 in a combined test, where a parallel project has analysed this problem. The project has been headed and carried out by senior researcher Lars Elsgaard, DIAS, Foulum. Results shows, that there is a measurable impact on the ecological environment in the processed soil volume. This was expected, but in contradiction to the expectations the regeneration shows a slow progress rate.

- The activities concerning precision seeding and (RTK) geo-positioning is finished. Results confirms that the system in principal is practicable. Though the analysis shows that the uncertainty is higher than expected due to agronomic resons as the germination path of the pedicel in the soil layer from the seed to the soil surface. The conclusion is that the system needs more research to obtain a reliability that proves the system to be ready for market. The RVAU Agro-Technology continues the work in other projects.

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C.2 Fulfilment of deliverables and milestones

(To be completed for each work package)

WP number and title **WP1: Technical process analysis**	Time schedule according to application	Deviations, if any*
Deliverables		
1.a: A setup for producing batches of thermally treated soil with a well-defined and documented treatment history.	(08/00)	
1.b: Documentation of the possibility of designing thermal soil treatment systems to give the soil a treatment with a given temperature history. The technical documentation includes heating source, temperature of transfer medium (heated air). The tillage/handling system is interacting with the soil.	(06/01)	
1.c: The theoretical energy consumption for different technical systems analysed under laboratory conditions.	(12/01)	
Milestones		
1.1 Establishment of laboratory processing rig capable of producing batches of heat-treated soil.	(06/00)	
1.2 Ready to carry out methodology test.	(09/00)	
1.3 1 phase of methodology investigations to be completed.	(06/01)	
1.4 Supplementary investigations and publication to be finished.	(08/01)	

** Deviations are to be discussed further in D*

WP number and title **WP2: Basic biological analysis**	Time schedule according to application	Deviations, if any*
Deliverables		

2.a: Draft paper for international publication on the basic model.	(06/02)	
2.b: Draft papers on 1) model extension and 2) crop establishment in pre-heated soil for international publication.	(06/04)	
2.c: National publication, as required.	(year 02-04)	
Milestones		
2.1 Preliminary structure of the basic biological model	(09/01)	
2.2 Completion of model extension to explain the impact of major factors affecting the biological effect of band-heating on weed seed germination	(09/02)	To be final-ised by the end of 2003
2.3 Final results on crop establishment in heated soil and statements on the agronomic consequences	(04/03)	

** Deviations are to be discussed further in D*

WP number and title **WP3: Establishment of prototype and technical field validation**	Time schedule according to application	Deviations, if any*
Deliverables		
3.a: Establishment of an operative prototype for field test.	(02/01)	
3.b: Establishment of an optimised prototype for technical field validation and validation of the basic biological knowledge.	(02/02)	
3.c: Documentation of the technical system	(11/04)	
Milestones		
3.1 Prototype 1 ready for field test.	(04/01)	

** Deviations are to be discussed further in D*

WP number and title **WP4: Biological field validation**	Time schedule according to application	Deviations, if any*
Deliverables		
4.a: Draft papers on the perspectives of a weed control system for row crops based on band-heating for intra-row weeding and automatically row-guided hoeing for inter-row weeding.	(Year 03-04)	
4.b: Arrangement of demonstrations and seminars.	(Year 03-04)	
4.c:		
Milestones		
4.1 Final plans for field experimentation.	(02/02)	
4.2 Finalising field experimentation with band-heating including validation of the performance of the band-heater prototype.	(08/03)	

4.3 A final description of the potential and practical implementation of band-heating techniques in organic as well as in conventional row-cropping systems for herbicide saving purposes.	(09/04)	

** Deviations are to be discussed further in D*

WP number and title **WP5: Precision sowing in treated bands and determination of seed positions**	Time schedule according to application	Deviations, if any*
Deliverables		
5.a: Conference paper about RTK GPS and precision sowing.	(10/01)	
5.b: Good adaptation of precision seeder to equipment of band treatment.	(01/02)	
5.c: Optimised seed placement tools of precision seeder with regard to special soil properties of treated bands .	(08/02)	
5.d Draft paper about determination accuracy of row and seed positions for international publishing.	(08/02)	
5.e Information of placed seed positions for inter-row hoeing and intra-row weeding.	(08/02)	* Delayed, finished
5.f Final report.	(08/02)	* Delayed, finished
Milestones		
5.1: Seeder ready for first field trials.	(08/00)	
5.2: First field trials finished.	(11/00)	
5.3: Results from first field trials available (accuracy of crop row and seed/plant position determination).	(03/01)	
5.4: Seeder ready for second field trials.	(08/01)	
5.5: Second field trials finished.	(11/01)	* Delayed, finished
5.6: Results from second field trials available (accuracy of crop row and seed/plant position determination in treated soil bands).	(03/02)	* Delayed, finished

** Deviations are to be discussed further in D*

D. Description of deviations and subsequent adjustments of plans

In general the activities has progressed as planned due to the tables of deliverables and milestones described in C2. The prototype optimisation has involved an supplementary innovation. The reason for this is that the idea of an alternative design concept arriced in the collaboration with the company Carl Oluf Madsen. The idea has been followed up, and the new design is ready for functional test in few weeks. Due to the time of the year a series of tests will take place in a field like environment to optimise the design for use in the final field tests in 2004. It has been possible to carry through this activity without compromising the overall goals and plans.

As the prototype 1. in principle is functioning satisfactory it has been possible to support the parallel project concerning analysis of the soil microbiology with test plots without big problems. The test plots also has been used as demonstration fields in during the season.

E. Project publications and other products

1. Articles in international, scientific journals with review procedures

   Griepentrog, H.-W., Nørremark, M. (2003). High accurate seed position mapping by using RTK-GPS. Precision Agriculture (peer reviewed journal, planned).

   Jørgensen, M.H., Kristensen, J.K., Melander,B. & Kristensen, E.F. (2004) Thermal band heating for intra-row weed control. Biosystems Engineering. (submittet)

   Melander B. (2004). Non-Chemical Weed Control: New Directions in. In: *Encyclopedia of Plant and Crop Science* (ed. Robert M. Goodman, University of Winsconsin)
   Marcel Dekker, Inc., New York USA, (accepted, in press)

2. Papers presented at congresses, symposiums, etc.

   Blackmore,S., Griepentrog, H.W. (2002). A future view of precision farming: 131-145. In: Proceedings 'Precision Agriculture', Bonn, 13-15 March 2002. KTBL, Darmstadt.

   Griepentrog, H.-W., Nørremark, M. (2003). The use of RTK-GPS for single plant care cropping systems. In: Proceedings of the 4th European Conference on Precision Agriculture, July 15-18, 2003, Berlin (planned).

   Griepentrog, H.W., Nørremark, M. (2001). Bestandesführung mittels kartierter Pflanzenpositionen: 285-290. In: Proceedings VDI-Tagung Landtechnik, Hannover. VDI Verlag, Düsseldorf.

   Jørgensen, M.H. & Melander, B. (2002). Band heating for intra-row control. Power and Machinery. Proc. AgEng 2002, Budapest. ISBN 963 9058 12 2ö, ISBN 963 9058 14 9, Abstracts Part 2: 130-131. CD Paper: http://www.gte.mtesz.hu.

   Melander B. & Heisel T. (2002). Prospects and limitations for agricultural engineering in the development of sustainable weed control methods – examples from European research. *Australian Conference on Agricultural Engineering, Charles Sturt University, Wagga Wagga, September 2002, 6 pp. (Proceedings available on CD).*

Melander, B., Heisel, T. & Jørgensen, M.H. (2002). Stribedampning og andre teknologiske nyheder til bekæmpelse af ukrudt i økologiske grønsager (Band-steaming and other technological novelties for weed control in organic vegetables). Den nasjonale kongress for økologisk landbruk 2002, Høgskolen i Hedmark Report No. 3 – 2002, 9-16.

Melander, B., Heisel, T. & Jørgensen, M.H. (2002). Band-steaming for intra-row weed control. 5th EWRS Workshop on Physical Weed Control. Pisa, Italy, 11-13 March 2002, (*http://www.ewrs-et.org/pwc/pdf/Pisa.pdf*).

Melander, B., Heisel, T. & Jørgensen, M.H. (2002). Aspects of steaming the soil to reduce weed seedling emergence. 12th EWRS Symposia 2002, Wageningen (NL), 236-237.

Melander B. & Jørgensen M. H. (2003). Band steaming for intra-row weed control in direct-sown vegetables. In: *Abstracts. European Weed research Society working group "Weed Management Systems in Vegetable Crops", workshop Skierniewice, Poland 26-27 June 2003, 13-15.*

Nørremark, M.; Griepentrog, H.-W. (2003). The use of RTK-GPS for high accurate georeferencing of field data. In: Proceedings of the 4th European Conference on Precision Agriculture, July 15-18, 2003, Berlin (planned).

Tei, F., Baumann, D.T., Bleeker, P.O., Dobrzanski, A., Economou, G., Fogelberg, F., Froud-Williams, R.J., Hoek, H., Melander, B., Rocha, F., Ruuttunen, P., Rzozi, S.B., Sanseovic, T., Simoncic, A., Torma, M., Uygur, F.N., van der Weide, R.Y., Verschwele, A., Villeneuve, F. & Zaragoza, C. (2002). Weeds and weed management in carrots: A review. 12th EWRS Symposium 2002, Wageningen (NL), 14-15.

3. Reports, articles in agricultural journals, etc.

Melander, B., Heisel, T. & Jørgensen, M.H. (2001). Stribedampning mod ukrudt i højværdiafgrøder (Band-steaming for weed control in high-value crops). Forskningsnytt om økologisk landbruk i Norden, No. 6. November.

Kristensen, J.K., Kristensen, E.F., Jørgensen, M.H. (2002) Termisk båndbehandling til ukrudtsbekæmpelse i planterækken, Gartnertidene, maj 2002.

Melander B. (2002). Hårde betingelser for Vestaustraliens økologer. *Økologisk Jordbrug 27 december, 4*

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

Griepentrog, H.W., Nørremark, M. (2002). Positionering af frø og afgrøderækker med RTK-GPS (Positioning of seeds and crop rows by means of RTK-GPS). In: Proceedings 'Teknik i Landbruget 2002', 21.05.2002, Aarhus (DK).

Melander, B. Three lectures at the Agricultural University in Copenhagen on 21 Nov. 2000, 23 Nov. 2001 and 1 Nov. 2003

Melander, B. Oral presentation at the EWRS working group meeting, Weed Management Systems in Vegetables, at Zaragosa, Spain, 4 June, 2001.

Jørgensen, et. al. (may 2002) Field demo and presentation, Maskindemonstrationen på Årslev.

Jøregnsen, et.al. (nov.2002) field demonstration and presentation, Theme: Thermal band heating for Weed Control: Bygholm (60 guests)

Melander, B. (2002) Scientific visit in Australia and New Zealand, 16 seminars.

F. Scientific education

None

G. National and international cooperation

The Agro-Technology group on the Swedish Agricultural University (SLU) has been inspired by the project, and has been able to attract funding to test the system under Swedish conditions. Together with a farmer there is build a nine row implement based on the concept from the 1. Prototype in this project. The Swedish results confirm the conclusions from this project.

Grower unions from Germany and Norway have visited Bygholm to get information and discus the concept.

From 8 Sep to 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.

H. Critical reflection on the project

As described the progress and the results of the technical and agronomic aspects of the project is satisfactory due to the described plans. The present status is that the functionality of the system is being analysed and demonstrated under field conditions, and that the further activities are concerned with documentation and optimisation of the system.

As mentioned, the thermal band heating system eliminates the need for an extensive manual weeding, and therefore, it is considered an attractive system. In spite of that – especially in the organic perspective – there are two negative side effects that require special focus, namely the influence on the microbiology in the treated soil and the energy consumption.

In the project initial planning it was decided to focus on the weeding process in order to establish a well-documented system. In this perspective, the analysis of especially the influence on the microbiology in the soil was left out; even it is very interesting and important. Now that the system seems to have a promising functionality, it is of benefit for the project that it has been possible to attract funding for a parallel project to analyse this problem during the grooving season 2003. The results shows that the effect is as expected, but

grooving season 2003. The results shows that the effect is as expected, but the regeneration shows a quiet slower progress than expected. This problem has to be analysed further before marketing of the system as an organic procedure. The results support the concept of an effective process control, so that it can be performed exclusively in narrow bands. This means that the main soil volume will remain undisturbed, – in the upper layer, as well.

When analysing the negative side effects, one should also pay attention to the positive elements. When the microbiology is repealed, the disease carrying fungi will also be eliminated. This could be expected to have a positive effect on some germination problems. Another fact is that thermal band heating has proved to be an almost 100% effective weed control method, the result being that weeding damage on the crop will not occur and that the row crops may again be the crucial element in a rotation where weeds can be removed effectively.

As mentioned, the required energy input under laboratory conditions is 170 l of oil per ha. Under field conditions by use of the first test implement, the consumption has been approximately 300 l oil per ha. This fact is the driving reason why the future research plans are aimed at reducing the input to the same level as that seen under laboratory conditions. In the energy input analysis it is important to bear in mind that the use of the system will eliminate the normal requirement for one perhaps two flaming operations and a manual weeding activity, which will often require more than 100 hours per ha. In this perspective, a consumption of 170 l/ha seems to be reasonable.

8. Budget

A. Account for any change in budgets

B. Budget for the whole project (1.000 DKK)

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

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	39	11	14		68
Technical personnel	33	9	4		47

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	745.000	375.000	490.000		2.180.000
Technical personnel	855.000	231.000	100.000		1.176.000
Other operational costs	405.000	84.000	72.000		561.000
Equipment					
Others (please specify)					
Direct costs	2.665.000	690.000	662.000		3.917.000
Indirect costs (20% of direct costs)	513.000	138.000	132.000		783.000
Total	**3.078.000**	**828.000**	**794.000**		**4.700.000**

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of Project			

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

Name of Institute: Danish Institute of Agricultural Sciences

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	24	11	14		49
Technical personnel	32	9	4		45

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	818.000	375.000	490.000		1.683.000
Technical personnel	785.000	231.000	100.000		1.116.000
Other operational costs	350.000	84.000	72.000		506.000
Equipment					
Others (please specify)					
Direct costs	1.953.000	690.000	662.000		3.305.00
Indirect costs (20% of direct costs)	390.000	138.000	132.000		660.000
Total	**2.352.000**	**828.000**	**794.000**		**3.965.00**

Comments:

Name of Institute: The Royal Veterinary and Agricultural University

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	19				19
Technical personnel	2				2

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	497.000				497.000
Technical personnel	60.000				60.000
Other operational costs	55.000				55.000
Equipment					
Others (please specify)					
Direct costs	612.000				612.000
Indirect costs (20% of direct costs)	123.000				123.000
Total	**735.000**				**735.000**

Comments:

B. Budget for each participating department (1.000 DKK)

Name of Institute and department: DIAS, Department of Agricultural Engineering

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	13	4	6		23
Technical personnel	19	5	4		28

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	455.000	140.000	210.000		805.000
Technical personnel	475.000	125.000	100.000		700.000
Other operational costs	260.000	44.000	44.000		348.000
Equipment					
Others (please specify)					
Direct costs	1190.000	309.000	354.000		1.853.000
Indirect costs (20% of direct costs)	238.000	62.000	71.000		371.000
Total	**1.437.000**	**371.000**	**425.000**		**2.224.00**

Comments:

Name of Institute and department: DIAS, Department of Crop Protection

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	11	7	8		26
Technical personnel	13	4	0		17

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	363.000	235.000	280.000		878.000
Technical personnel	310.000	106.000	0		416.000
Other operational costs	90.000	40.000	28.000		158.000
Equipment					
Others (please specify)					
Direct costs	763.000	381.000	308.000		1.452.000
Indirect costs (20% of direct costs)	152.000	76.000	61.000		289.000
Total	**915.000**	**457.000**	**369.000**		**1.741.00**

Comments:

Name of Institute and department: RVAU, Agro technology

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	19				19
Technical personnel	2				2

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	497.000				497.000
Technical personnel	60.000				60.000
Other operational costs	55.000				55.000
Equipment					
Others (please specify)					
Direct costs	612.000				612.000
Indirect costs (20% of direct costs)	123.000				123.000
Total	**735.000**				**735.000**

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

Name of Institute:

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months Scientific personnel Technical personnel					

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries Scientific personnel Technical personnel					
Other operational costs					
Equipment					
Others (please specify)					
Direct costs					
Indirect costs (20% of direct costs)					
Total					

Comments: