Evaluation report 2006

Evaluation of Research on Organic Production in Sweden

formas

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Preface

In Sweden, the government intends to increase the extent of organic farming, i.e. agriculture that does not use artificial fertilisers, herbicides or pesticides. Local production-consumption systems and animal welfare are also primary concerns in this type of farming. In order to establish the necessary science-based knowledge for such a development, previous governments have since the mid 1990s allocated earmarked funding for research to Formas and its predecessor SJFR. Calls for proposals were launched in 1996, 2001 and 2004.

The quality of Swedish research within organic farming has not been properly evaluated previously. The Board of Formas considered this deficiency to be an urgent issue and thus decided that an international evaluation should be initiated.

There are also other Swedish organisations funding research on organic farming, i.e. Swedish Farmers' Foundation for Agricultural Research (SLF) and the Swedish Board of Agriculture (SJV). SLU, the Swedish University of Agricultural Sciences, has also funded a minor program "EkoForsk". This evaluation has been implemented in co-operation between these organisations. With reference to jointly decided selection criteria, the organisations individually identified the research projects to be included.

The evaluation comprised projects that had funding during 1997–2004. In total, nearly one hundred projects, spending somewhat more than MSEK 200, were included. Since SLU had acted both as a funding organisation and a research performer, SLU representatives were absent from discussions and decisions on guidelines (including suggested evaluation criteria) for the expert panels.

The evaluation was performed in two parts, with one expert panel each. The first panel analysed the scientific quality and the second panel the societal impact. All the members of both panels were international reviewers. The funding organisations are very grateful to the panels for their important

and excellent work in analysing a significant amount of research. Special thanks to Roger Wilkins from UK and Kerstin Holmström from Finland for chairing the panels.

The recommendations given are highly appreciated by the funding organisations, and as we expect, also by the scientists, universities and institutes. Most of the research was considered to be of good quality in an international comparison. However, there were also evident aspects with a challenging need for improvements, e.g. international publication, visibility and co-operation, and research communication and interaction with stakeholders.

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Part 1.

Scientific Evaluation

Part 1. Scientific Evaluation

Summary

The Scientific Evaluation Panel was appointed in February 2006 to carry out an evaluation of the scientific quality of research on organic farming funded by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) (and its predecessor SJFR), the Swedish Farmers' Foundation for Agricultural Research (SLF) and the Swedish Board of Agriculture (SJV). Some of the projects were also financed together with the Swedish University of Agricultural Sciences' programme for organic production, SLU EkoForsk. The Panel was also asked to make recommendations on future research requirements. The Panel was charged to review all research projects funded by these organisations with at least EUR 20,000 from 1997 to 2004 for Formas and SLF and from 2000 to 2004 for SJV.

The projects were grouped into four topic areas: (a) Soils and Nutrient Management, (b) Crop Production and Protection, (c) Animal Production, Health and Welfare and (d) Socio-economics (including considerations of food chain, marketing and human aspects). The Panel identified the strengths and weaknesses of the programme at the topic level and then at the aggregated level of the whole programme.

The Panel agreed a set of criteria for the evaluation of individual projects. An overall assessment of each project was made independently by two members of the Panel. They also assessed the project for (a) general importance of the research topic, (b) specific importance for organic agriculture, (c) science quality, (d) the quality of the Principal Investigator, (e) the science output, and (f) contribution to capacity building (particularly in relation to training of Masters and PhD students). A scale from 1 to 4 was used with intervals of 0.5 – projects of the highest quality scored 4. The scores given by the panel members for the same project showed close agreement and mean scores were used.

A major feature was the large variation between the projects reviewed in the overall assessment. Some 26% of the projects were classified as 3.5 or above, with a further 19% with score

between 3 and 3.5, indicating that nearly half of the projects had reached very high standards. However, there were 28% of the projects with scores of below 2.5, representing rather disappointing outcomes from the viewpoint of science contribution. That a quarter of the projects reached high international standards is encouraging, but the Panel thought that the proportion of projects in the lowest category was rather high, even when allowing for some of the projects being carried out to satisfy funders' requirements for limited short-term outcomes.

The differences between different topic areas were in general smaller than the differences within topics, but the research in the socio-economic aspects of organic farming was somewhat weaker than the other three areas. Furthermore, in soils and nutrient management, there was a rather high proportion of topics in the lowest category. The proportion of projects in the highest category was highest for Formas and that in the lowest category for SJV, probably reflecting the applied nature of projects funded by that organisation.

Although there were some exceptions, the projects scored very highly for their importance for organic agriculture (mean 3.2) and highly for their general importance (mean 3.0). Thus this programme should make a substantial contribution not only to organic agriculture but also to scientific knowledge of more general relevance. The scores for the quality of the Principal Investigator (mean 3.3) were also high, indicating good scientific leadership, although there were a few projects where stronger leadership appeared to be required.

The projects varied markedly in their contribution to capacity building. The Research Schools have had the potential to make a major contribution, but the Panel did not have time to appraise their contribution in detail. We recommend that a separate evaluation is carried out on the Research Schools and their success in delivering their objectives.

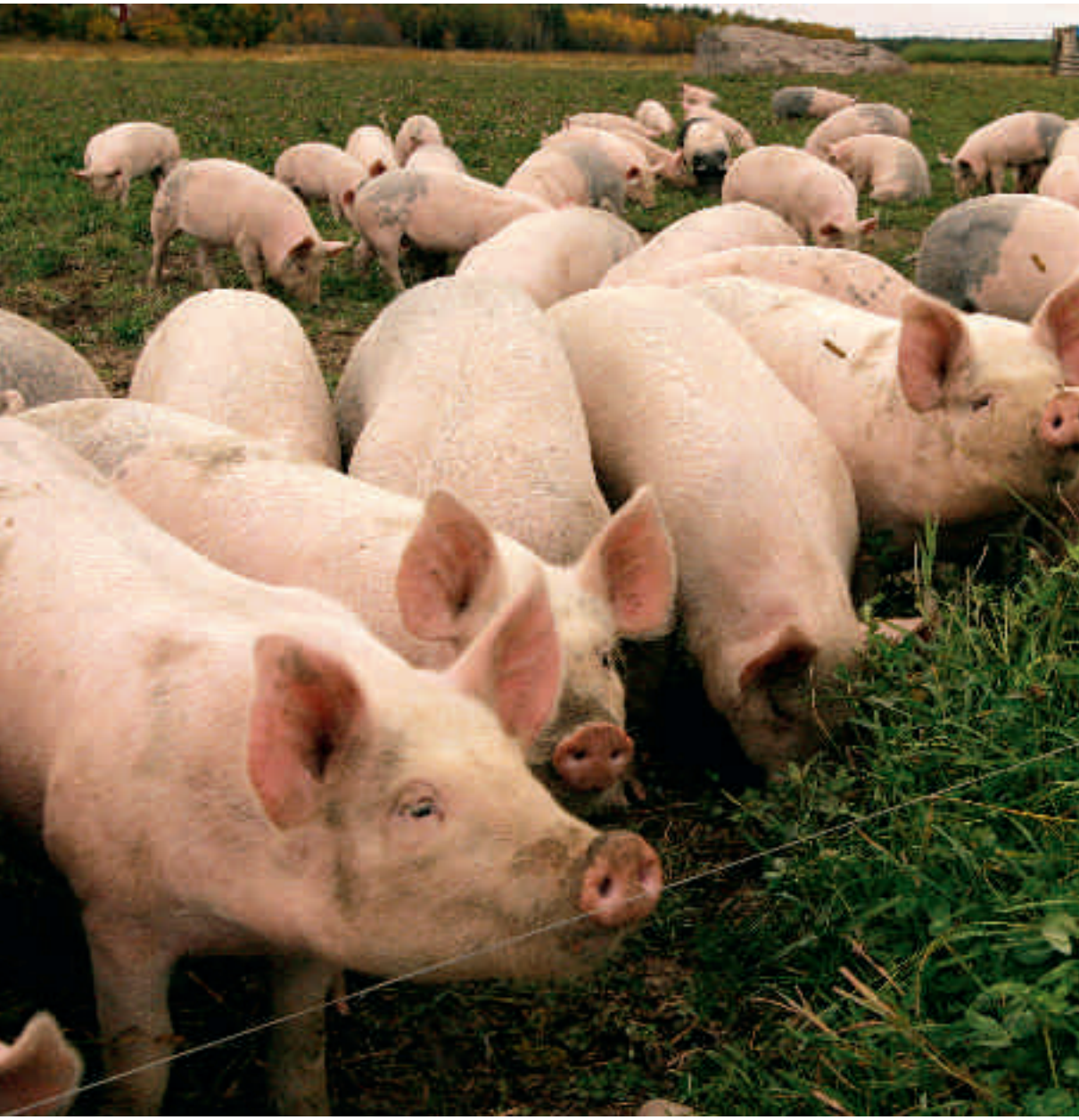
In view of the policy of the Swedish Government to encourage the development of organic farming and the management of up to 20 % land according to EU rules of organic farming, the Panel recommend a continued substantial commitment of support to research in this area. Such support is justified, based on not only the demand by consumers for organic food, but also the notion that organically managed farming systems will provide public goods in terms of ecological benefits and

services. It can be expected that research on organic farming topics yields high social benefits, leading to more sustainable use of land and other natural resources.

The Panel recommend that the future programme pays particular attention to three aspects:
1. Research on marketing, production and resource economic questions, as well as policy and social issues relating to organic production.
2. Integrated research on systems of production considering production, economics and the environment.
3. Component research on some of the key processes underpinning efficient organic farming.

The Panel was impressed with the extensive facilities in Sweden for organic research and the examples of excellent projects in the projects reviewed. However, it seems that this research had not yet achieved the recognition outside of the country that it deserves, and that efforts should be made to make this research more visible internationally. Many teams had developed good international linkages, but there were others where better international contact would have benefited the research.

We believe that increase in the visibility of the research would generate not only benefits for organic production more widely in Europe but also strengthen research in Sweden through forging more collaboration. It will be important for Sweden to continue to play a full part in European initiatives such as the CORE Organic programme and in Nordic initiatives. The profile could also be increased by hosting more international conferences in Sweden and more regularly involving international scientists in the coordination work of the Centre for Sustainable Agriculture (CUL).



Sammanfattning

Den grupp som utvärderade den vetenskapliga kvaliteten hos forskningen om ekologiskt produktion började sitt arbete i februari 2006. Tre finansiärers forskningsprojekt utvärderades: Forskningsrådet för miljö, areella näringar och samhällsbyggande (Formas) samt föregångaren SJFR, Stiftelsen lantbruksforskning (SLF) och Jordbruksverket (SJV). Vissa av projekten var även samfinansierade med SLU:s program för ekologisk produktion, EkoForsk. Gruppen blev också ombedd att lämna rekommendationer när det gäller framtida forskningsbehov inom området. Gruppen fick i uppdrag att granska alla forskningsprojekt som erhållit minst 20 000 euro under perioden 1997–2004 för Formas och SLF, samt under perioden 2000–2004 för SJV.

Projekten delades in i fyra ämnesområden: (a) Mark och växtnäring, (b) Växtproduktion och växtskydd, (c) Djurproduktion, hälsa och välfärd, samt (d) Socioekonomi (omfattar bland annat livsmedelskedjans flöden, marknadsföring och mänskliga aspekter). Utvärderingsgruppen har identifierat styrkor och svagheter på programnivå, men har utgått från de enskilda projekten.

Gruppen satte upp vissa kriterier för bedömningen av de enskilda projekten. En samlad bedömning av varje projekt utfördes av två oberoende medlemmar i gruppen. De bedömde även projektet beträffande (a) frågeställningens allmänna betydelse, (b) specifik betydelse för ekologiskt jordbruk, (c) vetenskaplig kvalitet, (d) forskningsledarens kompetens, (e) vetenskapligt utbyte, samt (f) bidrag till kompetensuppbyggnad, speciellt i samband med utbildning av studenter och doktorander. En skala mellan 1 och 4 användes, med intervall på 0,5 poäng, där 4 poäng innebär högsta kvalitet.

Det var stor variation mellan projekten i den samlade bedömningen. Cirka 26 procent av projekten klassades som 3,5 eller högre, ytterligare 19 procent fick poäng mellan 3 och 3,5. Det innebär att nästan hälften av projekten uppnådde en mycket hög vetenskaplig nivå. 28 procent av projekten fick dock en poäng under 2,5, något som tyder på tämligen dåligt

utfall när det gäller det vetenskapliga bidraget. Att en fjärdedel av projekten uppnådde hög internationell nivå är glädjande. Men enligt gruppens bedömning var andelen projekt i den lägsta kategorin alltför hög, även om man beaktar att vissa projekt utförts för att uppfylla finansiärers krav på begränsade kortsiktiga resultat.

I det stora hela var skillnaderna mellan olika ämnesområden mindre än skillnader inom ämnesområden, men forskningen inom det ekologiska jordbrukets socioekonomiska aspekter var något svagare än de tre andra områdena. Vidare fanns det när det gäller kategorin ”mark och växtnäring” en relativt stor andel projekt i den lägsta kategorin.

Med vissa undantag har projekten fått mycket höga poäng beträffande betydelsen för ekologiskt jordbruk (medelpoäng 3,2) och höga poäng beträffande allmän betydelse (medelpoäng 3,0). Forskningen inom ekologisk produktion kan därför anses bidra även till vetenskaplig kunskap av större allmän relevans. Medelpoängen för forskningsledarens kompetens var också hög (3,3), vilket tyder på bra vetenskapligt genomförande. Det fanns dock ett fåtal projekt där starkare projektledning antagligen skulle ha gynnat projektet.

Projekten varierade tydligt när det gäller bidraget till kompetensuppbyggnad. Forskarskolorna har haft potential att bidra till uppbyggnaden, men gruppen har inte getts utrymme att i detalj granska forskarskolornas bidrag. Vi rekommenderar att en ny utvärdering utförs beträffande forskarskolorna och deras resultat när det gäller kompetensuppbyggnaden.

Den svenska regeringens mål är att stimulera det ekologiska jordbrukets utveckling samt förvaltning av 20 procent av marken för certifierad produktion, enligt EU:s regler för ekologisk produktion. Mot bakgrund av detta rekommenderar gruppen fortsatt stöd för forskning inom området. Detta baseras på både konsumenternas efterfrågan på ekologiskt producerad mat, och på intrycket att ekologiska jordbrukssystem skapar ekosystemtjänster och hållbarhet. Forskning i frågor som gäller ekologisk produktion kan förväntas ge stor social nytta som leder till mer hållbar användning av mark och andra naturresurser.

Gruppen rekommenderar att det framtida programmet ägnar speciell uppmärksamhet åt tre aspekter:
1. Forskning om frågor som gäller marknadsföring, produktion

och resursekonomi, samt politiska och sociala frågor med avseende på ekologisk produktion.
2. Integrerad forskning i produktionssystem med avseende på produktion, ekonomi och miljö.
3. Komponentforskning i vissa centrala processer som utgör grund för effektiv ekologisk odling.

Gruppen var imponerad över de möjligheter som finns i Sverige för ekologisk forskning, och även av de exempel på excellenta projekt som fanns bland de granskade projekten. Det förefaller dock som om forskningen inte har nått den spridning utanför Sverige som skulle vara önskvärt, och att satsningar bör göras för att göra den ekologiska forskningen mer synlig internationellt. Flera forskargrupper har utvecklat gott internationellt samarbete, men andra skulle gynnas av bättre internationella kontakter.

Om forskningens synlighet ökas skulle det kunna skapa förutsättningar för en mer vidsträckt ekologisk produktion i Europa. Även forskningen i Sverige skulle stärkas genom ökat samarbete. Det är viktigt för Sverige att fortsätta delta i nordiska och europeiska satsningar, såsom CORE Organic. Sveriges profil skulle också kunna stärkas genom att större internationella konferenser anordnas, samt genom att internationella forskare mer regelbundet involveras i det samordningsarbete som bedrivs av Centrum för ekologiskt lantbruk (CUL).

Background

This review was initiated by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), who called for an international evaluation of the scientific quality and societal impact of research funded during the period 1997–2004. Formas collaborated in the evaluation with the Swedish Farmers' Foundation for Agricultural Research (SLF) and the Swedish Board of Agriculture (SJV) and also received input from the organic programme funded by the Swedish University of Agricultural Sciences, SLU EkoForsk. A Scientific Evaluation Panel was appointed in February 2006 to carry out an evaluation of the scientific quality of the funded research.

It was suggested that the Panel answer the following questions at the programme level:

- Have the research topics addressed been well adapted to the actual needs in agriculture and society?
- Has the research addressed the most important sustainability issues?
- Are there important issues missed by the actual research?
- Have the research topics addresses a well-motivated scientific rationale?
- Have the scientific methods used been appropriate and up-to-date?
- Has the scientific output in terms of scientific peer-reviewed publications been satisfactory, both regarding quantity and quality?
- Has the research been led by PIs of a sufficient scientific excellence?
- Have the research projects been internationally visible on international conferences to a sufficient extent?
- Have the research projects taken obvious opportunities for national or international scientific collaboration?
- Has the research contributed to capacity building (Master-/Lic.-/PhD exams) to an acceptable extent?

The Panel were asked to comment whether the answers to these questions varied according to the funding body involved and invited recommendations for future research priorities.

The Review Group and its Mode of Operation

Back row Juha Helenius and Roger Wilkins, front row Jan Tind Sørensen, Hermann Waibel, Christine Watson and Maria Finckh.

The Panel comprised:
Professor Roger Wilkins (Chairman), Visiting Professor of Agriculture, University of Plymouth, and Research Associate, Institute of Grassland and Environmental Research, North Wyke, England.

Professor Maria Finckh, Professor of Ecological Plant Protection, University of Kassel, Germany.

Professor Juha Helenius, Professor of Agroecology, University of Helsinki, Finland.

Dr. Jan Tind Sørensen, Head of Research Unit for Herd Health and Production Management, Department of Animal Health, Welfare and Nutrition, Danish Institute of Agricultural Sciences, Denmark.

Professor Hermann Waibel, Professor of Development and Agricultural Economics, University of Hannover, Germany.

Dr. Christine Watson, Reader in Organic Farming Systems, R & D Division, Scottish Agricultural College, Aberdeen, Scotland.

The Panel met in Stockholm on 15 March 2006 and in Uppsala on 22–23 May 2006. Reports on the individual research projects had been sent to the Panel prior to the first meeting. At that meeting, presentations were made by representatives of the funding bodies outlining their approach to commissioning and management of research and the Panel determined the approach it was to follow for the evaluation. At its second meeting, the Panel confirmed its assessments of the research projects, discussed papers prepared by individual panel members on particular areas of research, determined the structure of the final report and the recommendations to be made to the funders. A presentation was made at this meeting by Ulrika Geber, Director of CUL (Centre for Sustainable Agriculture), the body in SLU that coordinates research and communication on organic farming. Representatives of the funding bodies were on hand to resolve queries and to receive a preliminary report of the findings of the Panel. There was extensive communication amongst panel members by email.

The Panel received excellent administrative support throughout from Dr Sara Österman of Formas.

The Panel took the approach of building up from assessments at the level of the individual project to consideration of the programme at the topic level and finally the overall programme. The programme was divided into four topic areas: a) Soils and Nutrient Management, b) Crop Production and Protection, c) Animal Production, Health and Welfare and d) Socio-economics (including consideration of food chain, marketing and human aspects). Details of the procedure and criteria used are given later in this report.

The Panel also received written reports on the Research Schools that had been funded in this area and the coordination activities of CUL. The funders provided lists of the projects undertaken during the period of review for which reports were not available and of projects that are in progress in the present funding rounds. This information made it possible to assess the totality of research in Sweden in these areas.


ÖKRAGA FÖRSÖKSGÅRD

The Programme Reviewed

Evolution of programme

The three funding bodies take different approaches to the procurement of research.

Formas (and its predecessor SJFR) have ear-marked funding for research on organic production and issued calls for applications for research funding in 1996, 2001 and 2004. The calls presented in Appendix 1 detail a wide range of topics within which applications for funding were invited, relating to the components of organic systems, research at the systems level and research on socio-economic aspects. Formas select projects on the basis of science quality and are guided by a panel of experts and reports by referees. Whilst there is funding ear-marked for the programme as a whole, specific sums are not ear-marked for subjects within the overall programme.

The SJV programme is closely related to specific requirements. SJV launched its first programme for applied research and development in organic primary production in 1997. Their Framework Programme for the period under review is presented as Appendix 2. The 'Action Plan for Organic Production' launched in 2001 aims to fulfil the political goals of organic farming in Sweden. SJV will issue calls for work in specific areas and select the best project(s) from within the bids made. Some of these specific areas deal exclusively with organic production.

SLF funds research to strengthen the competitive position of Swedish agriculture. Its programme covers 15 areas, many of which are relevant to organic production (e.g. forage production, dairy production, soil and plant science), but there are no ear-marked funds for organic production. Each of the areas has a Planning Committee responsible for work within an area. Applications for support are assessed on a points basis with projects on organic production in competition with other projects.

The SLU's EkoForsk programme was not considered in detail by the Panel, because few projects had been concluded at the time of the review. Four of the reviewed projects, however, had co-funding from SLU EkoForsk and a list of other projects was also provided to the Panel subsequent to the preparation of its draft report and these are included in the review of currently-funded research for completeness.

Composition and funding of programme

The number of projects are listed according to topic and funding body in Table 1 and the costs are given in Table 2. Only projects with total cost above 20,000 euro were included in the review. The total cost of the 74 projects reviewed was MSEK 201, with 109 from Formas, 21 from SJV, 9 from SLF and 3 from SLU's EkoForsk. A further MSEK 59 came from other sources – mainly 'internal' funding from the institution carrying out the research.

Reports were not submitted for a further 30 projects (excluding projects funded by SLU EkoForsk for which reports had not been requested), so that the complete programme could not be reviewed. The average cost of the unreported projects was smaller than that of the reported projects, so that despite 29% of the projects being unreported they represented only 16% of the cost of the total programme. The pattern of reporting was, however, uneven over the programme. Amongst the four topics, the unreported projects were highest for Crop Production and Crop Protection, representing 30% of the total costs, whilst amongst the funding bodies, unreported projects were highest for SLF at 50% (Table 2). The SLU's EkoForsk projects for which reports were not requested were also predominantly in the area of Crop Production and Crop Protection. The funders indicated the reasons for projects not being reported: retirement or resignation of the PI (11 projects), the PI going to a new position (8), the PI not giving priority to the request for information (6), ill health (4), whilst the results from one project had been incorporated into another report. The Panel were surprised that in instances where staff had changed, the funded Institution had not made arrangements for a report to be produced.

Table 1. Number of projects according to topic and funding body.

	Soils	Crops	Animals	Socio-economics	Total
Reported Projects					
Formas	15	16	5	11	47
SJV	5	1	2	0	8
SLF	1	6	4	2	13
Joint*	1	1	4	0	6
Total	*22*	*24*	*15*	*13*	*74*
Unreported projects					
Formas	2	4	5	1	12
SJV	0	7	1	0	8
SLF	0	7	1	2	10
Total	*2*	*18*	*7*	*3*	*30*
EkoForsk Projects**	**3**	**10**	**1**	**2**	**16**

* Projects involving funding from at least two of Formas, SJV and SLF.
** Projects in 2002–2004 programme for which reports not requested.

Table 2. Cost of projects according to topic and funding body (MSEK).

	Soils	Crops	Animals	Socio-economics	Total
Reported Projects					
Formas	31.8	29.2	37.0	10.9	108.9
SJV	9.8	4.2	7.1	0	21.1
SLF	0.7	3.9	3.6	0.7	8.9
EkoForsk	0.4	1.5	1.2	0	3.1
Other	19.1	13.2	18.2	8.7	59.2
Total	*61.8*	*52.0*	*67.1*	*20.3*	*201.2*
Unreported projects					
Formas	3.0	8.0	8.8	1.5	21.3
SJV	0	7.1	0.8	0	7.9
SLF	0	7.8	0	0.9	8.7
Total	*3.0*	*22.9*	*9.6*	*2.4*	*37.9*
EkoForsk Projects*	**2.6**	**10.3**	**0.7**	**4.0**	**17.6**

* Projects in 2002–2004 programme for which reports not requested.

Appraisal of Scientific Quality of Programme

The criteria used

The Panel were provided with reports on projects prepared by PIs using a format provided by Formas. A brief CV for the PI was also submitted. Researchers were also asked to submit copies of two journal papers derived from the project. In some cases the reports were prepared by PhD students who had worked on the project, rather than the PI. The reports submitted were not always complete. Papers were made available as requested for a proportion of the projects, but in many cases no papers were made available, because either none had been produced from the project or no response was received to reminders requesting the papers. Thus the quantity and quality of the information provided to the Panel was rather lower than had been hoped for, providing some difficulties for the Panel.

The Panel agreed a set of criteria for appraising the projects (Table 3). Attributes were scored on a scale from 1 (low) to 4 (high) at intervals of 0.5. Each project was appraised by two members of the Panel, which included the person on the Panel with the most expertise in the specific area and a second panel member. Panel members made written comments on the reasons for the scores given. There was very close agreement in the assessments made and only 2–8% of the assessments differed by more than 1.0 for the different attributes. Where there was an initial discrepancy of this magnitude, the Panel members looked again at their initial scores in relation to the comments made. In most cases the revised scores gave closer agreement between the appraisals. Mean values were then used in the evaluation.

For the overall assessment, a score of 3.5 or above was considered to represent science of high international standard in relation to both the work carried out and the way that it was reported; a score of 3 or above represents a totally acceptable overall outcome with good quality science of international standing; a score of between 2.5 and 3 represents projects with either limited scope or showing some weakness in science

Table 3. Criteria used for assessment of projects. Scores made at intervals of 0.5.

	Score 4	3	2	1
Importance – general	Crucial need for more information for farm efficiency or society	Important aspect with little current information	Relevant, but with low probable impact on farm efficiency or society or reasonable information already available	Little relevance; information already available
Importance – organic	Crucial need for more information in relation to organic production	Important aspect for organic production with little current information	Relevant, but with low probable impact on organic production or reasonable information already available	Little relevance to organic production; information already available
Quality of research	Highly innovative research conducted efficiently with appropriate techniques and involving appropriate collaborations	Sound research conducted efficiently with appropriate techniques and involving appropriate collaborations	Design and techniques used are generally sound	Design flawed or use of inappropriate techniques
Quality of PI* Need for quality to be 'appropriate' for the needs of the project. Some general guidance given across	*For complex projects:* PI with strong international reputation in area of research as reflected in publications, editorships, invitations to present papers at international conferences and international collaborations. *For smaller straightforward projects:* PI with experience in research area, publications and reputation at national level	*For complex projects:* PI with experience in area of research with good publication output and international involvement through presentations at conferences or collaborations	*For complex projects:* PI with either (a) little experience in research area, but accomplished in other areas or (b) experience and reputation established only at national level *For smaller straightforward projects:* Evidence of reputation at national level not required	*For all projects* PI with little experience in research area or with poor recent published outputs
Science output**	High output in appropriate journals with presentations at national and international conferences	Some refereed papers and contributions at national and international conferences	A single refereed paper and contributions only to national conferences	Output only on non-refereed publications and at conferences
Capacity building	Several examples of capacity building	Some examples of capacity building	A single example of capacity building	No contribution

	Score 4	3	2	1
Overall assessment This is not intended to be a mean of the scores given above	Excellent research in an important area with significant scientific outputs	Good research in an important area conducted efficiently and with appropriate scientific outputs	Research that has generally been conducted satisfactorily but has low relevance or scientific output	Research that is poorly executed or in an area with little relevance

* There were some instances where CV forms had been completed for the PhD student who carried out the work, rather than for the PI. This should not have happened, but when it did, appraisers were asked either not to score or, if sufficient information was available, make a score appropriate for the person who appeared to be the PI.
** Allowances were made for: (a) the size of the project – obviously require more publications from larger projects, but funders had indicated that they would expect at least one refereed journal paper from all these projects and (b) date at which project completed – for projects completed by Dec 2004, the Panel expected papers by now to be at least at 'submitted' stage; for the few projects finishing in 2005 or not yet completed, appraisers did not have to score this aspect.

quality or reporting, whilst projects with scores of below 2.5 show marked weaknesses in conception, execution or reporting or were very limited in scope.

The Panel consider that a Research Council should be striving for its projects to reach an overall assessment of at least 3.0, whilst lower scores may be perfectly acceptable for projects which are funded to answer specific problems at the local or regional level.

Scientific quality of research in topic areas

These sections present an assessment of the projects reported to the Panel. They are discussed in relation to factors of importance for organic farming systems, the aspects highlighted in the call from the funding bodies, performance for different attributes and some concluding comments are made in relation to these reviewed projects. As noted earlier, there were a considerable number of projects that were not reported and there is an on-going programme of research on organic production. In order to provide a fuller picture, and to facilitate identification of gaps and future priorities, brief summaries, based only on project titles, are given at the end of the topic reports for unreported projects and current projects. Future priorities are discussed in a later section.

Soils and Nutrient Management

In considering this topic, the Panel initially allocated projects to three sub-topics – soil function, nutrients and nitrogen fixation, and manures. Draft reports on these subtopics were prepared by Juha Helenius (soil function), Christine Watson

(nutrients and nitrogen fixation) and Roger Wilkins (manures). These draft reports were discussed by the Panel at its May meeting and this consolidated topic report was then drafted by Christine Watson and agreed by the Panel.

The maintenance of a living soil is central to organic farming. Organic farming systems rely on the management of soil organic matter to enhance the chemical, biological, and physical properties of the soil, in order to optimise crop production. Soil management controls the supply of nutrients to crops, and subsequently to livestock and humans. It also plays a key role in controlling nutrient loss to the environment and in sequestering carbon. Furthermore soil processes play a key role in suppressing weeds, pests and diseases.

Managing nutrient resources efficiently in organic systems is a key to both productivity and reduced loss to the environment. Nutrient management for organic systems brings the additional challenge over conventional systems, because nutrients such as phosphorus (P) and potassium (K) are often in genuinely short supply and there are difficulties over sources which are acceptable within the philosophy/standards of organic agriculture. The major source of nitrogen (N) supply in organic systems is N fixation by legumes. Managing N fixation and the release of N after legume crops have been incorporated into soil is still a major challenge for organic production. The effective supply of nutrients from manures is particularly important for the achievement of adequate crop yields in organic systems. Both animal manures and green manures are important, with green manures being particularly significant in systems that do not involve livestock. In addition to supplying nutrients to subsequent crops, the nutrients from manures are at risk of loss to the environment

In this topic, the research programme should focus on issues of soil biology relevant to crop production in organic farming. These include root-microbe interaction for utilisation of nutrients. Avoidance of N and P losses in leaching, or C and N as greenhouse gas emissions is a goal closely linked to soil function. The storage, handling and application of livestock manures to maximise nutrient recovery by the crop and to minimise losses to water and the atmosphere are important topics in organic farming. The production and handling of green manure crops are important for the same reasons. It is important for the research to be considered within a systems context, particularly with respect to the links between soil/

nutrient management and plant health, and for attention to be given to economic as well as environmental aspects.

The Formas (SJFR) call for 1996–1998 highlighted "utilisation and minimum loss of nutrients", "turnover of organic materials", and "stability of cultivation systems through utilisation of biodiversity and natural mechanisms". One of the key areas is identified as "functioning ecocyclic systems" which points to recycling of organic materials (such as sewage sludge or composts) to production. This is closely linked to soil function.

Under the key area "technical-biological systems for organic agriculture and horticulture", the Formas call for 2001–2003 highlights "soil biology and soil physics" in relation to technology/technical systems. It also highlighted greater knowledge of the significance of non-N, P and K nutrients and the supply of nutrients in systems without livestock, as well as new and better management systems for organic manures and fertilisers.

The call for 2004 highlighted, among other issues, "control of weeds, pathogens and insect pests without chemical pesticides", "turnover and losses of plant nutrients", and "biodiversity and ecosystem services in the landscape". These all relate to soil function.

The SJV programme highlights prevention of leaching, promotion of soil fertility and nutrient management in sustainable crop rotations.

The projects reviewed

This overall topic area included 22 projects with a total spend of MSEK 60.72.

There were ten projects focused on nutrient management with a total spend of MSEK 22.79, including 11.9 from Formas, 0.3 from SLF, 4.91 from SJV and 6.09 from other sources. The SLF funding was for one project, SJV funded 2 very large projects and the other 7 projects were funded by Formas varying in size from MSEK 0.19 to 4.4. Three projects focused specifically on N fixation, one specifically on phosphorus and one on potassium. One project was concerned with nutrient balance methodology and use. The remaining projects generally focused on nutrient use efficiency but included more than one nutrient.

In the area of manure management there were five projects with a total spend of MSEK 17.26, including 11.00 from Formas, 4.90 from SJV, 0.36 from SLF and 1.00 from other sources (SLU and Foundation). Although Formas was the largest funding body, their support was directed to only one large project, whilst SJV was the major funder for four projects. Three of the projects were concerned with green manure crops focusing on nutrient recovery and to a lesser extent on environmental losses, whilst two projects dealt with animal manures, with one concerned with the effects of application times on soil characteristics and the other studying plant nutrient contents of poultry manures.

The seven projects on soil function had a total spend of MSEK 20.67, including the internal funding. All the projects were externally funded from Formas only, by MSEK 13.80. Two of the projects were concerned with mycorrhizae, one focused on the effects of manures on soil bacteria, two dealt with soil carbon (and nitrogen) storage, and one focused on methods to analyse nutrient elements on soil particles by spectroscopy.

Importance of research

The scores for project importance were generally high with 2.9 for general and 3.2 for importance to organic farming. These scores are not surprising, as soil management and balancing the supply and demand of nutrients is accepted as a major challenge for organic farming. Their importance reflects existing knowledge gaps and demand for information in the industry. However, managing nutrients from non-soluble fertiliser sources is also a considerable challenge in conventional agriculture, particularly against the goals of environmental sustainability.

Table 4. Scores for different attributes for projects on Soils and Nutrient Management.

	Percentage of projects in score bands				
	Mean	**3.5+**	**3–3.49**	**2.5–2.99**	**<2.5**
Overall assessment	2.69	23	18	23	36
Importance – general	2.90	23	32	23	23
Importance – organic	3.22	46	27	23	4
Quality research	2.97	18	36	36	9
Quality PI	3.29	60	5	20	15
Science output	2.38	27	4	14	54
Capacity building	1.93	17	4	9	73

Quality of research

Quality varied considerably with the overall score ranging from 1.5 to 4. With an average overall score of 3.0, and 12 of the 22 projects scoring 2.5 or less, the quality was perceived to be rather low for many of the projects. However, two soil microbiology projects and two nutrient management projects were excellent with an overall score greater than 3.5.

In some cases in the soils area it was very difficult to assess the quality of the research as the available information was limited. This reflects the fact that some project reports were very brief and in other cases no published papers were made available.

Quality of PI

The quality of the PI was considered to be variable. Across the soils area, eleven of the projects were led by scientists with strong international involvement and standing, whilst in other cases the PIs had limited national and international experience and publications. A number of projects were identified which could have benefited from stronger leadership. The quality of the PIs was considered excellent in the soil function area, where all the PI's scored 3.5 or above.

In some cases limited information about the PI made it impossible to score this attribute.

Science output

In all there were 37 papers published in refereed journals from the topic area. These represented 19 from the nutrient management area, 16 from the soil function area and only 2 from the manure management projects. Output per project was very varied from two projects with no current or intended publications to one project with 7 published peer-reviewed papers. Many projects listed intended peer-review journals but for projects which ended more than 2 years ago it is hard to believe these outputs will be achieved. In association with the Food 21 programme, two journal special issues (European Journal of Agronomy and Soil Use and Management) have been published; one focuses on nutrient management and one on element balances. These should be seen as significant programme level outputs, although this programme is only partly responsible for these special issues.

In contrast to the poor output of journal papers, the output of conference papers and presentations was quite reasonable

across the whole soils area. Even for applied research, though, this cannot be regarded as a satisfactory sole output. The overall score for science output was 2.4, with a range of 1 to 4. Where projects were at an early stage or there had been a major difficulty, such as illness of the PI, this category was not scored.

Capacity building

The soils area scored badly in terms of capacity building, with an average score of only 1.9.

The projects on manures contributed little to capacity building, although both the soil function and nutrient management areas had one or two projects which showed excellent capacity building through both PhD students and outreach.

Overall assessment

There is one group of five projects, which has produced good science with significant outputs internationally (overall score > 3.5). Three of these were concerned with soil function and two with nutrient management.

There is another group of twelve projects (scores of ≤ 2.5), which appear rather mundane and have generally poor outputs. In many cases these focused on topics important for organic farming and the projects should have delivered outputs such as refereed papers to enable a more rigorous examination of the research. The remaining projects were generally satisfactory but could have benefited from improved national and international collaboration. They should also have produced more outputs.

Concluding comments

There are a number of flagship projects that involve groups of national and international scientists. These have delivered or promise to deliver both value for money and a significant contribution in the following areas:

- nutrient management on organic farms in relation to N, P and K (systems level and plant/soil interactions)
- rhizosphere biology in relation to soil function
- soil structure management

There are however a number of projects which lack novelty and are very disappointing in what they appear, from this exercise, to have delivered. This reflects poor reporting as well as poor outputs. In many cases, for example animal manures,

there is now a large volume of relevant work worldwide and care must be exercised in avoiding duplicative research.

The whole area of soil management and nutrient use is fundamental to organic production, but requires integration with other aspects of crop and livestock production. This is essential if the systems emphasis in the first Formas call for projects is really to be achieved. In the future more will be achieved from large integrated projects, than from smaller projects concentrating only on one component within a system.

Unreported projects

There were two unreported projects within the soils area, both funded by Formas. One was concerned with the use of green and animal manures for supplying the plant nutrient requirements of tomatoes (MSEK 1.4) and the second with the production of a digestion residue of high ammonium content (MSEK 1.55). There were three SLU EkoForsk projects, for which forms were not asked for, dealing with plant nutrient strategies (MSEK 0.8), soil mixtures for organic production of horticultural seedlings (MSEK 1.2) and the effects of breaking a soil crust on growth of autumn-sown cereals (MSEK 0.6).

Current projects

There are four current projects funded by Formas, to a total of MSEK 10.6. These continue to address N fixation and K management. One project is aimed at S, which may be an element of increasing deficiency in organic systems. The final project addresses N_2O loss; this is an area which had not received much attention in organic systems when the project was funded in 2004. The SLU EkoForsk 2005–2007 programme includes three projects to a total of MSEK 3.3 dealing with symbiotic N fixation in clover-rich leys, N mineralisation after application of organic fertilisers and the improvement in plant nutrient management through the cultivation system.

Crop Production and Protection

In considering this topic, the Panel initially allocated projects to four sub-topics: plant characteristics and genetics, weed control, disease control and pest control. Draft reports on these subtopics were prepared by Juha Helenius (plant characteristics and genetics and weed control) and by Maria Finckh (disease control and pest control). These draft reports were discussed by the Panel at its May meeting and this consolidated topic report was then drafted by Maria Finckh and agreed by the Panel.

Specific to crop production in organic farming, in comparison to conventional mainstream practices, are reliance to non-manufactured sources of plant nutrients and non-chemical pest and weed controls. Generally speaking, for organic farmers:

- Nitrogen is fixed by bacterial symbionts of legume crops. The N fixed may be made available to subsequent crops by breakdown of soil organic matter, be re-cycling of animal manures or by the use of green manure crops in the rotation. Alternatively, N may be imported in the form of organic fertilisers.
- There are few to no possibilities to control plant disease epidemics or insect outbreaks once they have reached the logarithmic phase of increase.
- Also, in general, if there are any organic pesticides available, they are not as effective as conventional pesticides; they may work at low to moderate disease or pest levels, but not if there is high inoculum pressure.

Both in terms of nutrient economy and pest and weed control, organic farming sets specific requirements and research needs for crop species and cultivars, for rotations, and for crop husbandry.

The research programme should focus on:

- Identifying organic traits and ideotypes, and, if the market is judged to have sufficient commercial potential, the breeding of organic cultivars for improved nutrient acquisition and resistance.
- Husbandry of green manuring crops and design of rotations for efficient N-fixation, maintenance of soil organic matter and soil fertility including methods for soil improvement.
- Improving known, and developing novel, methods of pest and weed control based on cultural, biological, and possibly also physical methods. These include (i) Basic research on population biology of the noxious organisms and their natural control agents at local and landscape scale to achieve improved habitat management, (ii) identification of specific breeding goals, and (iii) seed and field hygiene, including effective microbial and other natural treatments.

Clearly, crop production and protection needs to be looked at as the integration of soil fertility management, with the understanding of soil functions being crucial to understanding effects on crops, pests and diseases. Thus, projects on soil function and soil fertility are also of relevance here.

The Formas (SJFR) call for 1996–1998 highlighted "creation of a cultivation system for the control of weeds, diseases and insect pests". Utilisation of biodiversity and natural mechanisms, knowledge of biology of the organisms, landscape level management, variety mixtures and cultivars were mentioned. Throughout, systems approach and multi-disciplinarity were emphasised.

Crop production (crop science) research is less explicitly referred to in the 1996–1998 call. In the context of "rational management of plant nutrients" greater knowledge of the processes that are important in organic farming systems with limited supply of imported nutrients is mentioned. Attention is given to turnover of organic materials and effects of cropping measures on soil fertility.

The Formas call for 2001–2003 takes rather different entry points. One of the key themes is titled "The ecology of cultivation systems". Again, pest and weed problems are given much attention. Dynamics of weed and pest populations in agricultural landscapes, interaction of crops, noxious organisms and their antagonists, as well as farming measures to manage these, are mentioned. Again, traditional crop science issues are not addressed. Instead, effects which a large-scale change (the political goal now being 20% certified farmland) may have on ecological processes in agricultural landscapes are highlighted. This is featured under the theme "Multifunctional agricultural systems". In order to achieve such integrated and interdisciplinary research goals, the call encourages formation of groups that bring together researchers and students from a number of key natural scientific areas. Under the key theme "Technical biological systems for organic agriculture and horticulture", the importance of linking technological and applied biological research is emphasised.
The SLF call is directed more towards component research, however projects within the context of the organic system are explicitly invited.

The projects reviewed
There were a total of 24 projects reviewed in this section allocated MSEK 39 from external funds and a total of MSEK 52. There were three projects dealing with genetic resources and breeding methods (MSEK 9.6), three with weeds (MSEK 12), seven with diseases (MSEK 7), 11 with insects (MSEK 23), with two of them specifically addressing agricultural systems questions. Seventeen projects received funding from Formas

(MSEK 31), seven from SLF (MSEK 4) and two projects received additional money from SJV (MSEK 4.2). Project duration varied from 1 to 8 years with some of the long projects to be finished in 2006 or 2007. Duration of the disease projects varied from 12 to 58 months with a mean of 31 months, while the insect projects varied from 12 to 60 months averaging 39 months. The three breeding projects lasted 36, 43 and 60 months, the weed projects 56, 76, and 96 months. This reflects the need for longer-duration projects to achieve results in plant breeding and in weed management based on rotations and mechanical management technologies.

Two of the three projects dealing with genetic resources were concerned with breeding goals for organic farming (competitiveness, allelopathy, nutrient acquisition ability, quality under low-input conditions, etc.) and availability of variation for these goals in cereals, while one dealt with the need to adjust disease resistance breeding methods for clover. In addition, in several of the disease and insect projects, newly identified selectable traits for plant odours or inducibility of resistance were also of importance.

Research in entomology was dominated by six projects on chemical ecology (dealing with all kinds of semiochemicals in more or less specific situations). There were three projects dealing with natural enemies and biocontrol of insects and two looking at the effects of landscape on distribution patterns of insects and their natural enemies. These two latter projects evolved out of an earlier project by adding questions of scale and landscape structure. Six of the seven projects on plant diseases dealt with biocontrol on different levels ranging from the search for specific biocontrol organisms against specific pathogens above- and below-ground to more general protection systems via mycorrhiza, endophytes, compost composition, or products derived from composts. One of the disease projects dealt with a specific disease.

In addition to the projects directly dealing with diseases and insects, there were a number of projects in the section on soil function that indirectly affect the health of the system. These are cross-referenced, where appropriate.

As two of the weed projects are still running, no final assessment of these is possible with respect to research quality, science output, and capacity building. Also, the genetic resources projects were at least partially of the R&D type with the

output producing the basis of future strategic breeding efforts and only partly innovative research methods.

A summary of the scores given for different attributes is given in Table 5.

Table 5. Scores for different attributes for projects on Crop Production and Protection.

		Percentage of projects in score bands			
	Mean	**3.5+**	**3–3.49**	**2.5–2.99**	**<2.5**
Overall assessment	2.92	36	20	16	28
Importance – general	3.20	50	33	0	17
Importance – organic	3.28	58	21	12	8
Quality research	3.00	46	8	21	25
Quality PI	3.22	52	9	30	9
Science output	2.79	38	12	21	29
Capacity building	2.09	11	6	17	67

Importance of research

Overall the importance of the projects was rated high with a mean of 3.2, with the disease and weed projects considered rather lower (2.9) than those on genetic resources and insects (3.3 and 3.4, respectively). The lowest importance rating was 2 and the highest 4. With respect to organic farming, the importance was similar, except for the weed projects which were considered especially important (3.3).

The lower scores for the disease projects were due to a lack of systems context in many cases. Some dealt with diseases that should not be a problem if proper rotation is used in a system. Also, the development of microbial biocontrol organisms to be applied above-ground in the field is generally to be considered an unrealistic approach. On the other hand, the importance of biocontrol organisms for the soil can also be questioned, as a biologically highly active soil will work as a system and most likely suppress introduced organisms. Therefore, different approaches should be looked for with respect to most diseases (see below).

The approach to insect management via semiochemicals is overall sound and makes a lot of sense, especially where questions of host genetic background and structure of the agricultural system up to the landscape level are considered. Much of the insect research appears to be well connected among research groups and thus is developing synergisms. Overall, however, it is not clear, how much of the research results have

found their way into the applied world and if the step from small-scale laboratory and field experiments to the larger-scale will be successful.

Quality of the research

Out of 24 projects, several were difficult to assess in this respect, as these either had not produced research publications (7), the reports were very scant or published papers were not made available. The impression was however, that all the projects met at least acceptable standards in terms of research quality with a mean of 3. The insect research scored highest with a mean of 3.4, while research on diseases was only rated at 2.6 and genetic resources and weed control 2.8. There was only one disease project dealing with a systems approach that reached the highest rating in research quality; the other six were rated below 3 for lack of innovation in their approach and topic. Only three insect projects were rated below 3, mostly for lack of innovation. The research into novel breeding goals relevant for organic farming and into mechanical weed control was considered highly innovative

Quality of PI

The scores for research quality are mostly reflected in the quality of the scientists involved. Overall, the quality was rated as 3.2. It was accepted that for less complex projects, less experience and publications were required for a high score. In a few cases, information on the PI was not available, and the quality was not evaluated. The pathologists scored lowest with a mean of 2.9, while the entomologists scored 3.7, which is to be considered outstanding overall.

Science output

The output of journal papers was very variable among the projects. Six projects have not produced any output, with three of these finished for quite some time, two still running and one finished in Dec 2005. For the latter project, however, at least one paper could be expected by now. The lack of output here may be due to the fact that all of the project contributes to a PhD thesis.

Overall, there are 56 published papers and eight submitted. The overall mean was 2.3 publications per project.

Five of the ten pathology publications resulted from one single project, while two projects produced no publication at all. Among the entomology papers, 13 out of 32 stemmed from

one single project, two projects have produced no papers so far and one has submitted one paper; the other projects resulted in 1–5 publications.

With respect to total funding, and assuming that the submitted papers will be published, the cost per publication was SEK 812,000; considering only the funds from Formas, SLF and SJV, the cost was SEK 613,000.

Capacity building

With respect to capacity building, it appears from the reports that only very few MSc and PhD theses were completed. The MSc theses in most cases are listed without the titles and therefore it cannot be ascertained if they were really derived from the projects.

The highest scores in capacity building were achieved by the weed projects (3) and the entomologists (2.3), while very little was achieved in pathology (1.3). The low scores in genetic resources are due to the involvement of the non-university sector and can thus not be compared with the other projects. The overall score was 2.1.

Overall assessment

The overall assessments ranged from 1.5 to 4.0, with a mean of 2.9, indicating a good overall quality of the projects. Twelve of the projects, however, received overall scores below 3. Again, the mean for the pathology projects was lowest with 2.4 while for the entomology projects it was highest at 3.3. The lack of innovation and the relatively low relevance of some of the pathology projects to organic farming contributed to the low overall rating there.

Concluding comments

Almost all the projects were considered important to organic farming. The projects covered fairly well the aspects highlighted in the Formas calls with the focus being either on breeding or in plant protection issues. The projects did not include traditional crop husbandry (crop science) studies; this may be because of lack of competitive applications or because the main emphasis in the programme was elsewhere. It is unlikely to have arisen from a shortage of interesting and relevant topics.

Only two of the projects addressed the system level. However, really interdisciplinary work was still missing there, as the

economic and social impacts were ignored. In this sense, the emphasis given to system development in especially the first call was not realised in this topic. However, bits and pieces of knowledge contributing to the development of crop production systems for organic farming were definitely produced.
While there is much need for research in plant protection, there is a need to focus more on a systems approach. This has generally been addressed more successfully by the entomologists than the pathologists. On the entomology side, there is a need to carefully evaluate the results of a few projects that approach the same topic from different angles (apple moth, e.g.) and then a decision needs to be made on the best approach to continue. On the pathology side, projects that address single diseases are very limited, because for the most part solutions must be found by altering the farming system. Care has to be taken not to fund within an organic programme work on diseases of relevance in high-input uniform systems but of low relevance in proper organic systems where management will include rotations.

Overall, some of the research in soil microbiology not reported in this section may be of greater relevance and help for the future than most of the pathology projects, because the functionality of the soil microbial community with respect to disease suppression is a key component influencing plant health.

Work on breeding goals and genetic resources for organic farming is of great importance. This work is often also connected to plant pathology and entomology and care should be taken that diseases and pests relevant in organic farming are included in the screening process.

Quite a few of the reports were very scant and could therefore not be properly evaluated. Also, more emphasis has to be put on the publication of the results and on capacity building.

Unreported projects
At least 16 out of the 31 projects that were not reported are dealing with crop production (judging by the titles). These included a topic in crop rotation, potato production, topics in the area of horticulture (vegetables in open field, tomato in glasshouse, apple in orchard), and a more exotic topic with narrower, specific interest. Eleven projects dealt specifically with plant diseases, none with insects. Quite a few of these projects appear to deal with the growing system, e.g. for

potatoes (MSEK 3.7) or with the very important topic of legume diseases (MSEK 1.4). Other topics include allelopathy (nematicidal effects), systems effects on the soil microbial community, seed hygiene, storage disease control. These are all very important topics.

There were ten projects in the SLU EkoForsk 2002–2004 programme, for which forms were not asked for. Three of these were dealing with weed control and seven with production systems for specific crops, including potatoes, quality wheat, oilseed rape, grass and legume seed crops and legumes for forage. Assuming some success in these projects, the programme has covered a much broader range of relevant issues in this topic than appears from the reported 24 projects.

Current projects

Overall, there are 32 current projects in the area of crop production funded through SLF (11), Formas (15) and SJV (6) covering a wide and interesting range of topics relevant to organic farming. The projects include secondary metabolites in vegetables as a quality issue, selection of genotypes with high N-use efficiency, weed competition and allelopathy in cereal breeding materials, relay cropping, production of narrow-leafed lupin for feed, methods for evaluation of soil and plant analyses in organic farming, organic production of strawberries, seed rate and row spacing in cereal and faba-bean production, varieties for forage, development crop production, and an issue of cadmium in wheat.

The projects funded through SLF address the development of integrated crop production systems not specifically directed towards organic farming and product quality. The crop protection projects deal with biofumigation, seed treatments, biocontrol of soil-borne organisms and in hydroponics, biocontrol of insects, and control of potato late blight.

Without knowing the contents of the projects, little can be said about most of them. However, as explained above, biocontrol of soil-borne organisms needs to be looked at much more in the context of a systems approach rather than looking for organisms to be brought into the soil. Recent research in the Netherlands has shown convincingly that bringing biocontrol organisms into a living soil has relatively little effect. Soil-borne diseases of oilseed rape are not of high relevance, as they can be dealt with by proper rotation.

Biofumigation in the context of rotation management might be of interest but must not be looked at without looking at the complete rotation and the economics.

Hydroponics are not allowed in organic production and it appears strange that a project on such an artificial system should be considered in an organic programme.

Formas currently funds 15 projects dealing with crop production making up for about MSEK 37 out of the 64 allocated. All projects are rather large in comparison to former projects, reflecting possibly a change in policy towards more systems approach oriented topics. The projects are in a large part a continuation of the previously funded successful projects in landscape scale research, breeding and insect research, but there is also now some research on the integration of rotation, nutrients and plant health.

In contrast to before, SJV has started to support a wider range of relevant topics, especially in problem weeds and high value but small sector commodities that are often neglected in research. This reflects the goal to expand organic production beyond the standard field crops into vegetable and fruit production.

The 2005–2007 SLU EkoForsk programme includes two projects on weed control and projects on disease control in tomatoes, pest control for fruit and berries and for the production of herbage seed crops, potatoes and oilseed rape.

Animal Production, Health and Welfare

In considering this topic, the Panel initially allocated projects to three subtopics: ruminant production, monogastric production and animal health and welfare. Draft reports on these subtopics were prepared by Roger Wilkins (ruminants) and by Jan Tind Sörensen (monogastrics and animal health and welfare). These draft reports were discussed by the Panel at its May meeting and this consolidated topic report was then drafted by Jan Tind Sörensen and agreed by the Panel.

Organic animal production systems are regulated by EC regulation 2092/91 and involve:

- Organic produced feed including a fixed proportion of forage depending on species
- Requirements for animals to graze during part of the year or at least to have access to an outdoor area.

The concept of animal health and welfare is very important in organic livestock and poultry production. If these high standards are not achieved, it could have detrimental effects on consumer interest. The EU-regulation focuses on preventive health strategies, access to outdoor areas and minimising veterinary drug inputs. There are specific rules for housing, such as: loose housing, bedding and minimum space allowance, and a requirement for late weaning. So it is important for organic livestock and poultry production to achieve a high level of animal welfare and disease control. Research plays a major role for developing systems improving animal health and welfare in a sound economic framework.

Thus the feeding and husbandry practiced in organic dairy cattle herds may be very different from that in other herds (with milk yields and concentrate use being very high in 'conventional' Swedish herds) and the type of animal best fitted for organic systems may also differ from that in conventional systems. These differences produce real challenges for the evolution of efficient organic ruminant production systems, particularly in the dairy sector, which normally has the most intensive systems. Product quality is also particularly important for the organic sector, as producers strive for high quality products that will sell at premium prices.

It is difficult to achieve a good balance with organic egg production. For productivity reasons hens are kept in fairly big flocks (3,000 hens per flock) and only a fraction of the hens use the outdoor areas. The balance between productivity, animal welfare and environmental impact is the key problem to which research can play a major role. Organic broiler production is currently a very small niche production and effective systems for organic broiler production have not yet been developed.

The problems in organic pig production are very similar to organic egg production. However organic pig production is currently a niche production with less importance. The new rules for animal density implemented in 2000 in the EU has increased production cost, so there is very much interest in increased productivity in organic pig production. Even in organic systems, pig finishing is typically indoors, in contrast to the expectations of many consumers. There is a major task to develop alternative methods of finishing based on pasture.

The Formas call in 2001 highlighted the need for work on production systems with domestic livestock with the emphasis on pigs and poultry. The call stressed the need to develop completely new systems for animal management and the need to focus on optimising the entire production system. Attention was drawn specifically to the need to optimise feed regimes based on domestic or locally-produced raw materials. SJV noted the need for research on a) systems for exercising tethered animals, b) vitamin supply, c) grazing systems for parasite control, d) effects of method of production on taste of products, e) increased protein supply and utilisation using regionally produced feed and f) conservation and storage of feed (for instance whole-crop cereal).

We would expect the research programme to focus strongly on a) the supply and use of home-produced feeds of high nutritive value that can give efficient plant and animal production within organic rules, b) the utilisation of grazed grassland feeds, c) the use of feeds to promote animal health and d) the impact of the production system on animal welfare and product quality and e) animals appropriate for organic systems.

The projects reviewed

The projects reviewed are discussed within the subtopics ruminants, monogastrics and animal health and welfare.

Four project reports were focussed on ruminants. They were though large projects with a total spend of MSEK 16.19, including 8.68 from Formas, 2.18 from SJV, 0.33 from SLF and 8.66 from other sources (EU, SLU, Mistra). Three of the four projects were concerned with the characteristics and use of home-produced feeds. One of these projects considered animal health as well as nutrition and involved grazing animals. The other two projects involved housed animals and concentrated on nutrition. The fourth project was concerned with the quality of milk produced in organic and conventional systems.

Five projects focussed on the subtopic monogastrics. The projects had a total spend of MSEK 28.5 including 21.5 from Formas, 1.7 from SJV and 0.6 from SLF. Egg production is addressed in three projects. All three projects address problems aiming to improve productivity, but also animal welfare. Two large projects address organic pig production. Both projects basically focus on productivity through improved breeding

and feeding. One project addresses broiler production, focusing on developing a true organic concept for broiler production.

The subtopic animal health and welfare included seven projects. The projects had a total cost of MSEK 23.0 including 11.1 from Formas, 2.4 from SJV and 2.5 from SLF. Six projects focus on disease control. Only one project addresses animal welfare in dairy cattle, including various aspects such as calf and cow welfare. Two projects addressed research to minimise mastitis. These were relevant to milk quality as well as animal welfare.

Parasites in relation to productivity and animal welfare on grazing cattle were addressed by two projects. Egg production is addressed in one project focusing on control of ectoparasites and one project addressed disease prevention in broiler production.

The assessments made for the different categories are summarised in Table 6.

Table 6. Scores for different attributes for projects on Animal Production, Health and Welfare.

	Percentage of projects in score bands				
	Mean	**3.5+**	**3–3.49**	**2.5–2.99**	**<2.5**
Overall assessment	2.88	22	33	28	17
Importance – general	2.81	12	44	19	25
Importance – organic	3.06	44	19	25	12
Quality research	3.06	38	25	25	12
Quality PI	3.52	62	25	12	0
Science output	3.05	44	31	0	25
Capacity building	2.56	12	25	19	44

Importance of research

All projects on ruminants were within the general priority areas indicated above, but inevitably they did not form a comprehensive or cohesive programme. The project scores for 'Importance–organic' ranged from 2.25 to 3.50 (mean 2.8), with two projects receiving relatively low scores, because although relevant to organic production, the approach was not geared to the specific problems of organic production. Assessments for general importance were similar to those for importance for the organic sector, reflecting relevance of the research to other forage-based systems.

The five projects on monogastrics were given scores for general importance between 2 and 3.5 (mean 2.6) indicating that

the projects include some important aspects. As described above, there is a range of specific problems linked to organic monogastric production. The importance of the projects for the organic sector was rated higher (mean 3.4) than that for general importance.

The seven projects on animal health and welfare rated 2.5 or higher for general importance (mean 3.0). The mean rating for organic importance was 3.0.

Quality of research

Mean scores for quality of research on ruminants varied from 2 to 3.75. The lowest score was for a project that involved very simple comparisons, no driving hypothesis and low originality. Research quality was high in the three other projects. Three of the four projects benefited from national and international collaboration, with one being part of a multi-national EU project.

Mean scores for the monogastric projects varied between 2.25 and 3.5. The quality of research in the subtopic animal health and welfare was high (between 2.5 and 3.75).

Principal investigators

Three of the four projects in ruminants involved spends of over MSEK 4 and were quite complex. They were however led by PIs with strong international reputations, although in one case the PI had come rather away from the forefront of research.

The quality of staff in monogastrics was in general acceptable. The PI was excellent in all seven projects in the subtopic animal health and welfare, with scores varying between 3.25 and 4.0.

Science output

All projects in the ruminant area had journal papers that were either in press or published, with a total of 12 papers at these stages. This represents a higher output per project than in most topics, but the total spend at MSEK 1.45 per paper is high. There should, however, be further journal papers produced, as one large project has only recently finished. The research has been featured prominently outside of the country with all projects having papers presented and published from international conferences.

The science output was a weakness in three of the five projects in subtopic monogastric (between 1 and 1.75). The combination of a relatively high quality of research and a high organic importance indicate that more papers should have been produced.

Science output was good in all projects in the subtopic animal health and welfare (mean score between 3.0 and 4.0). In two of the project reports it appeared that not all the publications listed derived from the project in question, but even so the output is good.

Capacity building
All projects in subtopic ruminants had made some contribution to capacity building, with three of the projects receiving scores of 3 or above. The capacity building in the two other subtopics varied a lot between the projects from none to several theses being produced.

Overall assessment
The scores for overall assessment were good for two of the ruminant projects at 3 and 3.5, but were rather disappointing at 2.5 and 1.75 for the other two projects, with these lower assessments being related to low science output and low quality of research respectively. The overall assessment for projects in the monogastric subtopic ranged from 2 to 3.25. For animal health and welfare the overall assessment was good for all projects, ranging in score from 2.75 to 3.75.

Concluding comments
Research on ruminant animals can be difficult and costly. This makes it imperative that projects have clear and important objectives. For work on organic production it is particularly important to plan and consider the research within a systems context and, in many cases to consider the inter-relationships between different parts of a system.

One project provided an excellent example of research that addressed an important issue and spanned different disciplines in a well-coordinated manner. It produced six refereed papers and indicated some good opportunities for the future – every assessment was at 3.5 or above. In addition to projects of this type, there is a place for some research relating to components of efficient production. Two projects were in this category, but they would have benefited from having been tied

in more closely to the context and particular nutritional problems of organic farming. It was good to see a project looking at milk quality, but we should have moved beyond the stage of comparison between organic and conventional products on to research to seek to deliver particular quality characteristics by manipulating the organic production system.

It is notable that there were no projects in subtopic ruminants concerned with animal type in relation to organic systems and little emphasis on grazing. The four projects funded only scratched the surface of the priorities identified in the calls from the research funders. At least two of the four projects could have been directed more strongly to the priority areas. Only one of the projects was beginning to address issues at the systems level.

The projects in the subtopic monogastrics address in general key questions in organic monogastric production. There was a major commitment to research on organic pig production. Two projects alone cost a total of MSEK 22. This is a major strategic investment decision in relation to the very low production of organic pigs. It may be questioned as to whether this emphasis can be justified for the future.

The subtopic on animal health and welfare seems to be in good hands by Swedish researchers. They focussed on important topics for organic livestock and poultry production. The projects were carried out by high quality staff and they gave important and well-disseminated results.

Unreported projects

There was one unreported project in the ruminant area. The project was funded to MSEK 1.8 by Formas and concerned with the use of inhibitory lactic acid bacteria for silage and feed biopreservation. There were three unreported projects in the monogastric subtopic costing MSEK 2.2, 1.3 and 1.4. In the subtopic animal health and welfare, there were two unreported projects.

The SLU EkoForsk 2002–2004 programme included one project, for which form was not asked for, on the regulation of legume growth by mixing different varieties of ryegrass with white clover (MSEK 0.7).

Current projects

There are four current projects with funding totalling MSEK 2.6 from Formas and about MSEK 1 from SJV. Two of these are concerned with the production and use of high forage diets for milk production, one with the study of possible genotype-environment interactions in dairy cows in the context of the possible need for a breeding programme for bulls for organic milk production and the third is a small project on the development of automatic tethering systems for cows. These projects are certainly in line with the priorities of the funding bodies. It is good to see some work on animal genetic aspects, whilst the studies on feeds appear to be more closely related to organic systems than was the case in the earlier programme.

There is one SJV project with a 2006 budget on MSEK 0.5 and one Formas project with a budget on MSEK 4.9 (on broiler production) in the monogastric area. There are four current Formas projects on animal health and welfare (MSEK 1.0, 1.4, 2.0 and 2.4) focusing on parasites in sheep, lungworm in cattle, health in dairy cattle and natural animal behaviour. A total of 12 current projects are funded by SJV in the areas of animal health and welfare. These cover a range of topics, with major emphasis on parasite control. There is also a new project on vitamin supply from forages.

The 2005–2007 SLU EkoForsk programme includes five projects dealing with animal production with a total cost of MSEK 7.1. The projects concern mainly feeds for organic dairy production, including research on tanniferous forages to improve N supply, the use of faba bean-spring cereal mixtures and feeds in relation to vitamin supply. Projects also deal with the optimisation of diets for organic poultry production and the protein quality and fatty acid supply in hemp seeds.

Socio-economic Aspects of Organic Farming, including Food Chains, Markets and Human Aspects

In considering this topic, the Panel considered at its May meeting a draft report from Hermann Weibel. He revised this report and it is agreed by the Panel.

As in many other European countries, organic farming in Sweden is receiving considerable policy support, primarily because land use systems under organic farming are believed to generate outputs that result in goods and services of a public goods nature. These goods include, for example, various types of ecosystem services such as better habitats for plant and

animal species and increased biodiversity. The fact that such goods are characterised by non-rivalry and non-exclusiveness explain that they normally are undersupplied or not supplied at all by the market. Organic farming is also believed to have less negative externalities, such as water pollution by nitrate and chemical pesticides often attributed to conventional farming. The exclusion of these industrial inputs in organic farming requires the use of management technologies like crop rotation, mulching, green manuring and the use of more robust and disease resistant varieties. These natural resource management techniques can generate positive externalities in terms of water quality, soil fertility and more attractive landscapes. Although products from organic farming generally command a higher price, the value of these externalities is not necessarily internalised in the product price because of their public goods nature and institutional deficits to internalise them. On the other hand, many studies have shown that there is a willingness to pay for such goods and services in the society. Since these consumer preferences are not revealed through market prices there is a classic case for government intervention.

The Swedish government is supporting a policy of organic farming and has set land use targets of 20 % of the land to be certified under EU regulations. Very recently the increase in the consumption of organic food by public organisations has been encouraged to reach a share of 25 %. The existing policy framework opens up a series of research questions regarding effective and efficient policy implementation and expected consumer and producer response. Such research needs are mostly related to agricultural and environmental economics, economic geography and other social sciences.

This topic, which corresponds with the areas identified as Food Chains, Markets and Human Aspects and Multifunctionality in the call for research on organic farming by Formas, covers a wide range of research topics that are related to the social sciences and economics. For example, the Formas call identified a number of topics in the economy-market-consumption area where information was needed arising from the changes in the production and marketing system attributable to the change from conventional to organic farming. The principles and standards of the organic farming system relative to the conventional farming systems require changes in the organisation of farms and additional investments. Most importantly organic products demand a change

in marketing strategies, including product differentiation and this requires a more active role of producers in the marketing process as compared to most conventional farming systems. Another area of potential interest of research is the assessment of the social value of the non-market goods generated as by-products in organic farming (e.g. ecological functions, landscape, biodiversity, human health benefits, etc.). Finally, research on policies and institutions, as well as the role and perception of organic farming among different groups of the society, are important topics.

The research projects actually carried out in this programme on organic farming gave emphasis to the production-market related questions in the context of rather more component research. Larger integrated projects that addressed questions of externalities, spatial and policy implications had not been carried out. Few of the projects that were presented had addressed issues of labour, other human factors and perceptions of society.

The projects reviewed

There were 13 projects that were classified in the broader category of socio-economics. These projects included topics like investment under uncertainty and market structures in organic pig production, land use strategies, life cycle assessment of milk production comparing organic and conventional production, working conditions in organic production systems, stakeholder participation in ecosystems management, collective action and ecosystems management understanding, farmers evaluation of priorities of agricultural societal and ecosystems priorities, strategies and policies of institutional reform for ecological farming development, the use of biofuels in organic farming, natural resource management and energy efficiency, sustainable organic meat production and ecological and human benefits from integration of animal husbandry in organic farming and forestry.

The total budget in the eight projects in this category was MSEK 8.8 or roughly SEK 670,000 on average. This is a lower cost per project than in the subject areas of technical research. This seems appropriate, as social science research is less capital intensive than research in the natural sciences that often requires expensive equipment.

The scores for different attributes are summarised in Table 7.

Table 7. Scores for different attributes for projects on Socio-economics.

	Percentage of projects in score bands				
	Mean	**3.5+**	**3–3.49**	**2.5–2.99**	**<2.5**
Overall assessment	2.50	15	0	54	31
Importance – general	2.75	15	23	46	15
Importance – organic	2.90	23	38	15	23
Quality research	2.35	0	23	31	46
Quality PI	3.02	46	15	15	23
Science output	2.58	15	23	23	38
Capacity building	2.12	15	4	15	69

Importance of research

Most projects in this category addressed questions which are of interest beyond the realms of organic farming. Undoubtedly, the projects included in this portfolio were important. However, one could ask whether the topics chosen were really addressing the most important questions given scarcity of the research budget. With the exception of one or two research projects, the topics do not seem to be sufficiently specific in addressing the questions that were described in the research programme call.

For example, comparing the 13 projects by their title and project description with the formulated research needs as laid down in the call, topics that are important for the policy framework for organic farming of the Swedish government such as "economic measures and policy instruments for the promotion of ecosystems services" or "design of multifunctional agricultural systems at landscape level" were not explicitly represented in the projects that were carried out. While some aspects of these issues were dealt with, the visibility of the research results is too low to meet the importance that these socio-economic topics deserve.

Quality of research

The quality of the research is somewhat lower than what one could expect. The average score among the projects reviewed is below 2.5. To some extent the low score may be attributable to poor description of the research methodology and poor linkage between methods and results in the project reports. It is possible that the reviewers' assessments may underscore the actual quality of the research. In many cases it was difficult to judge whether the methodologies described would lead to the results that were expected or that have been described. The

description provided on research methods was simply insufficient to make a well-informed judgement. In some cases the description of the methodology raises doubt regarding scientific rigour and the way the research was conducted. Also, there were cases where interesting research had been conducted resulting in publications in high-class journals, but the research was addressing natural resource management in developing countries and had limited relevance to problems in Sweden. Whilst the Panel was informed that research for developing countries was part of the Formas remit, the direction taken by these projects may have compromised the original intention of the funding agencies.

Quality of PI

Taking the scores as a basis one can say that quality of the PI was apparently better than the quality of the research. The average score of PI quality is around 3 with a range from 2 to 4. An important aspect is that for some of the PIs their level of internationalisation, as demonstrated by their intensity of international collaborations, may be lower than ideal for achieving international recognition of the research results. Some of the project investigators are undoubtedly "high class" but it appears that the topic of organic farming is not among their major research fields, which may limit the degree of attention they might give to the reviewed projects.

The variation regarding the level of internationalisation among PIs was high. Judging from research topic and methodology, it was not always clear whether the main area of expertise of the PI was in the field of the respective research projects.

Science output

Science output in general could be called moderate, but there was variation between projects. The average score was slightly above 2.5 but with a range from 1.5 to 4. Some researchers had produced internationally peer-reviewed journal papers which are attributable to the research described, but this is not always the case and some of the publications listed appear to have been the result of other research. Only 10% of the projects reached a score of 3.5, considered necessary for the output to be regarded as of high international standard. Some researchers only had papers in local journals and there was one case where not even a research report was produced. There is also a question of time lag from project completion and submission or acceptance of papers by journals. In some

cases this seems fairly high. Much of the research was carried out by PhD students, including those studying under the Research School on Organic Land Use (ReSELU).

Capacity building

Average score was lowest for this category at just over 2. Again, the range from 1 to 4 is high. The same is true for the variance, but with a distribution that is skewed towards the lower end. Most research involved PhD students, but in spite of the reported completion of the project, some of the PhD students had not yet submitted the thesis. We did not have opportunity to discuss the training of PhD students in detail, but completion times seemed to be very long. One can of course only speculate about this gap in time, but two explanations seem plausible. First, the research was not well conceptualised and the methodology was not rigorous enough to produce results of high scientific quality. Second, the PhD student may have been engaged in other activities with less concentration on his/her thesis research. Naturally, in PhD supervision there are factors beyond control and one popular saying is that: "the success or failure of a PhD research is decided in only one day, i.e. the day when the student gets hired". Nevertheless, the low capacity building output indicates the existence of a somewhat underdeveloped research culture and that there should be greater use of the instruments of monitoring, milestones, evaluation and impact assessment. This criticism could perhaps be addressed to researchers, research managers and the funding agencies.

Overall assessment

The overall assessment of the projects in the socio-economic portfolio makes reference to the overall score. This represents a subjectively weighted score from the different assessments, paying particular attention to science quality and science output. On average this was 2.5, with a range of 2 to 4. Two factors really pulled down the assessment for this research topic. One is the very low capacity building output and the second is the quality of science as far as it can be judged from the description of the research. There was a close relationship between quality of science and science output, suggesting consistency in the assessment. There was also a general difficulty to judge the link between methods used and results, because the latter could not always be verified. It is possible, however, that some of the variation in overall research quality and output may be due to the highly interdisciplinary nature of some

of the research projects. This can sometimes be at the expense of the scientific rigour usually employed in more narrowly focussed component research.

The projects that were carried out are certainly interesting, but the innovativeness of the research was often not demonstrated clearly. In general the research projects were relevant for both general agricultural research and organic farming research but it must be emphasised that the topics sometimes deviated from what the Panel saw as the required major research focus for this topic in the Swedish research portfolio.

Concluding comments

Most strikingly, there seems to be a gap between the priorities set out in the research programme and the actual research performed. There are a number of subjects that have not been addressed that potentially could yield higher rates of return to research than some of those presented in the list. For example, there was no project that looked at the role and potential of IT-based information systems on organic farming or producer-retailer consumer relations, i.e. one common problem in organic farming is to get sufficient quantities of supply at the right time.

Overall, the Panel submit that socio-economic research in organic farming was not given the level of attention it deserved. The political importance that the Swedish government is giving to the sustainability paradigm in the development of its economy and society in general and the emphasis on sustainable land use in agriculture opens up a lot of opportunities for exciting, nationally and internationally highly relevant research that could enhance Sweden's international recognition in agricultural research.

Unreported projects

There were two unreported projects allocated to this topic, with one relating to the maintenance of an experimental resource for studying organic farming in a multi-functional context and the second relating to the creation of multifunctional structures within the landscape. Neither had a strong socio-economic component.

The 2002–2004 SLU EkoForsk programme included two projects allocated to this topic. The research element within these projects was though rather low. One project (MSEK

3.6) involved documentation of research facilities available for use for organic research and on-going field trials. The second project was concerned with participatory learning and decision tools for use on organic farms (MSEK 0.4).

Current projects

Five current projects relate to this topic. These include a project on learning in local distribution systems and continued support for the SwOFF Research School. Other projects relate more to multi-functional systems including work on bio-based fuels, landscape ecology and ecological recycling.

There are no projects in this topic in the 2005–2007 SLU EkoForsk programme.

The programme overall

The assessments made across the complete programme are summarised in Table 8.

Table 8. Scores for different attributes for the overall programme.

	Percentage of projects in score bands				
	Mean	**3.5+**	**3–3.49**	**2.5–2.99**	**<2.5**
Overall assessment	2.77	26	19	27	28
Importance – general	2.95	28	33	19	20
Importance – organic	3.15	45	25	19	11
Quality research	2.89	28	23	28	21
Quality PI	3.27	56	12	21	11
Science output	2.69	32	16	15	37
Capacity building	2.15	13	9	14	64

A major feature was the large variation between the projects reviewed. For the overall assessment, some 26% of the projects were classified as 3.5 or above, with a further 19% with score between 3 and 3.5. Thus nearly half of the projects had reach very high standards. However there were 28% of the projects with scores of below 2.5, representing rather disappointing outcomes from the viewpoint of science contribution. That a quarter of the projects reached high international standards is encouraging, but the Panel thought that the proportion of projects in the lowest category was too high, even allowing for some of the projects being carried out to satisfy funders' requirements for limited short-term outcomes.

The differences between different topic areas were much smaller than the differences within topics, but the Socio-economic area was rather weaker than the other three areas with only 15% of the projects having a score for the overall assessment of 3 or above. There were rather high proportions of projects in the lowest group for Soils and Nutrient Management (36%) and for Socio-economics (31%). The proportion of projects in the highest two categories was above 50% for both Crop Production and Protection (56%) and for Animal Production, Health and Welfare (55%).

The fact that there were projects with high international achievement in all of the topic areas indicates that there are some very high quality groups in Sweden.

Points are made below in relation to the attributes assessed by the Panel and the questions specifically put to the Panel:

Importance of the Research

This was assessed by the panel as Importance – General and Importance – Organic. It encompassed the specific questions:

- Have the research topics addressed been well adapted to the actual needs in agriculture and society?
- Has the research addressed the most important sustainability issues?

The scores were generally high, both for Importance – General and Importance – Organic. Thus results from the programme will provide substantial benefits to agriculture and society more widely than in the organic sector per se, particularly in relation to sustainability issues.

Some of the projects funded early in the period of review would have been strengthened if they had been conducted more tightly within the framework of organic farming and some projects paid little attention to the particular features and problems of organic farming in the papers derived from the project. The relevance to organic farming seems to be higher in more recent projects.

Whilst the research was generally highly relevant, there were some areas, particularly Socio-economics, in which it appeared that the issues being researched were not those of most crucial importance for the organic sector.

Quality of Research
This encompassed the specific questions:
• Have the research topics addressed a well-motivated scientific rationale?
• Have the scientific methods used been appropriate and up-to-date?
• Have the research projects taken obvious opportunities for national or international scientific collaboration?

With the exception of the Socio-economics topic, scores for Quality of Research were generally high with the research topics being addressed using appropriate scientific rationale and appropriate and up-to-date methods. There were many good examples of national and international collaboration, but the Panel would have liked to see evidence of even more collaborations.

Projects in the Socio-economics area were generally rather small and many involved single PhD projects. It was often not possible from the information provided to be confident that appropriate methods were used and there were relatively few collaborations.

Quality of principal investigators
This encompassed the specific question:
• Has the research been led by PIs of a sufficient scientific excellence?

The scores were generally very high for this attribute, with the PIs responsible for the more complex projects having good publication records and substantial international experience. For less complex projects, the PIs generally had more than sufficient experience to provide leadership.

Particularly in the Socio-economics area, there were some instances where the PIs were moving into areas that seemed to be some distance away from their core experience and this provided some limitations. There were also a substantial number of projects for which the PI section of the report had been completed by the PhD student that had carried out the work. In that case, wherever possible, the Panel assessment referred to the person they perceived as the PI. Completion of PI details for the student perhaps indicates that the PI was rather removed from the research in these projects.

We were very surprised that, despite the PIs having strong track records and generally good published outputs, they had not instilled more urgency to achieve satisfactory published outputs.

Science Output

This encompassed the specific questions:

• Has the scientific output in terms of scientific peer-reviewed publications been satisfactory, both regards quantity and quality?

• Have the research projects been internationally visible on international conferences to a sufficient extent?

The output of the programme in scientific peer-reviewed publications was variable and, in aggregate, disappointing. We identified 189 papers that had either been published or were in press. Some 98 of these papers were the product of only 13 projects that had produced 5–13 papers each. In contrast, 20 projects had produced only a single paper and 18 projects had produced no papers. There were many papers listed as "intended for journals with peer review", but in many cases these related to projects that were completed several years ago. Doubtless, there will be additional papers produced, but the Panel was not confident that a large proportion of those listed would materialise. The papers that had been published were generally of good quality and had been submitted to appropriate journals.

The output from the most productive projects was very good. They were often larger projects with the average cost of the 13 most productive projects being MSEK 4.5, with a range from MSEK 1.5 to 9.0. In contrast the 18 projects with no papers had an average cost of MSEK 1.4 with range from MSEK 0.3 to 4.9. One of the 20 projects with only one paper was very large (MSEK 17); the others had an average cost of MSEK 2.5.

We considered that there was much publishable material that had been produced, but not been written up for publication. Actions to stimulate higher output of papers are discussed later.

The output in contributions to national and international conferences was more satisfactory, but the visibility of Swedish organic research internationally is not high, with most of the conference contributions being offered rather than plenary papers.

Capacity Building
This addressed the specific question:
• Has the research contributed to capacity building (Master/ Lic/PhD exams) to an acceptable extent?

The overall scores were rather low and there were many projects that gave no evidence of a contribution to capacity building. We believe, however, that our analysis probably underestimated the contribution made in this area. Firstly, we suspect that the project reporters did not fully list the theses and dissertations that had arisen from the work. Secondly, the forms used encouraged a rather narrow focus on theses and dissertations, whereas capacity may be increased in a broader sense by the forging of linkages between research groups and the development of national and international collaborations. Thirdly, the scoring system that we used for this attribute did not allow for variation in project size, so that it was not reasonable to expect high scores from small- to medium-sized projects.

The priority given to capacity building through training new scientists is higher for Formas than for the other funding bodies. The Panel believes that there were many opportunities for student projects to be developed within the programme and that they were not in all cases taken. The funding of Research Schools is an obvious important contribution to capacity building and is discussed in a later section. The PhD students that have worked in the programme as a whole represent a very substantial contribution to the Swedish capacity for research related to organic farming.

Other specific questions
The Panel was also asked to address the following question:
• Are there important issues missed by the actual research?

This is discussed in the sections relating to particular topics in the context of the projects reviewed, the unreported projects and the current programme. Some suggestions for future priorities are given later in this report.

Science quality of the research according to funding body and project size

The Panel were asked to comment on whether there were differences according to funding body. It was anticipated that such differences would exist because of the differences in policy

Table 9. Mean scores and percent of projects in different score bands for the overall assessment according to funding body and total project cost.

		Percentage of projects in score bands			
	Mean	**3.5+**	**3–3.49**	**2.5–2.99**	**<2.5**
Funding body					
Formas	2.86	31	16	31	22
SJV	2.42	15	15	8	62
SLF	2.81	24	35	18	24
Total cost (MSEK)					
>4	3.05	47	20	13	20
2–4	2.83	27	18	23	32
1–2	2.64	10	21	42	26
<1	2.61	16	26	16	42

Table 10. Mean scores for different attributes according to funding body and total project cost.

	Importance		**Quality**		**Science output**	**Capacity building**
	General	**Organic**	**Research**	**PI**		
Funding body						
Formas	3.02	3.18	2.94	3.35	2.68	2.29
SJV	2.77	3.08	2.94	3.00	2.38	2.02
SLF	2.88	3.18	2.91	3.31	2.85	2.18
Total cost (MSEK)						
>4	2.97	3.08	3.17	3.35	2.97	2.92
2–4	2.99	3.30	2.99	3.21	2.68	2.26
1–2	2.95	3.09	2.66	3.29	2.74	1.72
<1	2.89	2.93	2.79	3.24	2.42	1.68

and requirement between the funding bodies. The Panel also explored the possibility of there being generic differences according to project size.

Table 9 gives the mean scores for the overall assessment according to funding body and total project cost and the percentage of projects in different score bands, whilst Table 10 gives mean scores for the other attributes. The percentage of projects in different score bands for these attributes is given in Table 11. Where projects were jointly funded, they were attributed to all of the bodies providing funds. There were only four reviewed projects that received co-funding from SLU EkoForsk. These are not tabulated separately, but the projects are included within the mean scores for the co-funding organisation.

For the overall assessment there was a tendency for the scores to be lower for SJV than for the other two funding bodies.

It is notable that a high percentage of the SJV projects were in the lowest overall category. The scores for quality of research did not differ between funding bodies, but science output was lower for SJV. The low number of refereed papers was the main reason for the low mean overall assessment of the SJV projects. As noted earlier, the priority attached to refereed papers in relation to other forms of output varies between the funding bodies.

The overall assessment tended to increase with increase in project size, as did the quality of research, science output and capacity building. Some 47% of the largest projects achieved an overall score of 3.5 or above, whilst this was achieved by only 13% of the projects in the smallest two size categories. There were though examples of strong and weak projects across the complete range of project sizes and the Panel accepts that there may have been some bias in their assessment system towards large projects. However, as will be argued later, in order to make real progress with many of the problems of organic production, there is a need to take an integrated approach involving different disciplines and effort across the complete production process. Such an approach is only possible within large projects. The results of our analysis indicate that there is ample capability within Sweden to manage and deliver good results from large projects.

Table 11. The percentage of projects in different score bands for different attributes according to funding body.

	3.5+	3–3.49	2.5–2.49	<2.5
Importance – general				
Formas	30	38	15	17
SJV	15	38	23	23
SLF	36	21	21	21
Importance – organic				
Formas	45	31	16	8
SJV	46	15	31	8
SLF	53	18	18	12
Quality research				
Formas	30	18	33	18
SJV	33	20	33	13
SLF	38	31	6	25
Quality PI				
Formas	60	15	19	6
SJV	46	9	18	27
SLF	53	18	24	6
Science output				
Formas	33	14	17	36
SJV	31	8	0	62
SLF	38	25	12	25
Capacity building				
Formas	19	9	9	62
SJV	15	15	0	69
SLF	12	6	29	53

Research Coordination

The extent of coordination of research carried out by the funding bodies appeared to be rather limited. However, a major role is played by CUL (the Centre for Sustainable Agriculture of SLU). The Panel received a written report on CUL and also an oral presentation by Dr Ulrika Geber at its meeting in May. CUL was evaluated by an international group in 2003 and was not evaluated by this Panel. The work of CUL is, however, extremely relevant to this programme evaluation.

CUL was formed in 1997. It receives basic funding from the Swedish Government and attracts income from other sources. The basic funding was routed through Formas, but is now routed through SLU. CUL is a cooperation body focusing on organic agriculture for researchers and departments at SLU and stakeholders outside SLU for the development of interdisciplinary research methods and for co-ordination and co-planning of activities to help (a) research and long-term building of competence (b) development work (c) education and (d) information dissemination.

The Panel consider that a focus such as this is very valuable for organic research in Sweden. We were impressed by the activities of CUL in relation to the framing of a research agenda and encouraging collaboration between researchers and between students.

We noted that CUL takes responsibility for involving stakeholders in reviewing the requirements for research in these areas and has just produced a National Framework Plan. Previous experience indicates that this plan will have a major impact on the research priorities determined by the funding bodies. We did not have opportunity to review this Plan, but endorse the process that had been followed with wide stakeholder involvement.

The Panel strongly supports the initiatives that CUL has taken to help the evolution of research bids. It was indicated to us that CUL can provide limited funds to allow the preparation

of bids for research contracts. We think that this will be of increased significance in the development of good bids for integrative and multidisciplinary research that may require inputs from a number of partners. It may be appropriate for CUL to take a proactive approach in building such research consortia.

The existence of the focus in CUL is important in developing a profile for research in Sweden on organic production. We note that CUL organise a biennial national or Nordic conference. As discussed later, the Panel believe that the profile of Swedish research in these areas should be further enhanced and we encourage the hosting of international meetings and workshops and wider international participation in meetings organised by CUL.

Research Schools

The panel received written reports on the Research Schools ReSELU (Research School in Ecological Land Use, 1998–2003) and SwOFF-1 (Swedish Research School in Organic Farming and Food Systems, 2002–2004) and note that Formas provide funding in the current round for SwOFF-2. In addition to the written reports on the Schools, reports were submitted for individual PhD projects from within these Schools. These were evaluated alongside other projects.

An important objective of the first two research schools was to prepare inter-disciplinary researchers for their role in the future. They provided courses with an inter-disciplinary perspective and sought to achieve inter-disciplinary co-operation between the PhD students in the schools.

The Panel support the need to encourage inter-disciplinary perspectives in students and other researchers involved in research on organic production. However, the extent to which these goals had been achieved by the Research Schools was not clear to us. We did not have time to interview staff and students involved in the Schools and detailed evaluation of the Schools was not a specific part of our remit. ***We recommend that a separate evaluation is carried out on the Research Schools and their success in delivering their objectives.***

Future Requirements

In view of the policy of the Swedish Government to encourage the organic sector and the wide implications of the management of large areas of land according to organic rules, ***the Panel recommend a continued substantial commitment of research support to the organic sector***. This is required in order to make best use of land, for resource use efficiency, for the output of high-quality food and for environmental enhancement to benefit the nation as a whole. The report details priorities overall and for particular sectors. ***The Panel recommends that there is continued ear-marked funding for this area and that the research be carried out within the context of organic farming, rather than under the more general umbrella of sustainable farming systems.*** We consider that the rules of organic farming provide a valuable and internationally-recognised focus for research in this area. It also provides a strong reference point to Government policy. Despite this constraint, our findings suggest that such a programme would also have substantial wider scientific relevance. This section discusses initially the requirements and priorities within the four topics, but then considers the overarching features that we would like to see in a future programme.

Soils and nutrient management

The reported research on soil function was generally of a high standard and should be nurtured as it is likely to be successful in the future. Research relating to the impact of soil and crop management on below-ground communities is vital for the improved functioning of organic farming. This relates not only to production aspects, but also to environmental impact. This research should reflect the multi-functionality of organic systems and be integrated with the programme on crop plants, pathogens, and pests.

Research on manures has been so inadequately reported in journal papers, that it is difficult to really assess how much progress has been made and to have confidence that the researchers in this area will efficiently deliver results if they receive further funding. Nevertheless, nutrient supply from manures remains a crucial element in the efficiency of organic

systems and more information on the factors that determine the pattern of supply of N to plants from manures is required to increase plant uptake and reduce environmental losses. Rotational aspects are also important and further research is needed to establish the overall impact of the inclusion of green manure crops within a rotation on productivity, the environment and farm economics. The research on pattern of supply of N would require a combination of basic and more applied work and may be best progressed within the context of an international effort, whilst research on rotational effects is more appropriate for national or Nordic research and is closely in line with requirement highlighted in the SJV call. Recent changes in EU legislation on the use of organically grown feed for livestock are resulting in the need for better information on N-fixation and utilisation in grain crops. This should be linked to research on plant health in leguminous crops.

Research on nutrient budgeting and the use of N, P and K in farm systems has generally been good. It is clear that groups of Swedish researchers working with other international groups have made a major contribution to improved nutrient management. Future research should continue in this area, picking up the need to study interactions between different nutrients, and also trace element management in stocked and stockless organic systems.

It is important that the wider environmental and societal issues are taken into account more fully in future research. Soils provide important ecosystem services as processors of recycled organic materials and also as carbon stores. This is important at the farm, regional and national levels in terms of nutrient recycling and energy use efficiency. There has been very little research on no- or low-till systems for organic farming, soil function is an important aspect of this in terms of both nutrient cycling and plant health.

Crop production and protection

Crop production forms the basis of all agricultural production. For developing organic crop production, the issues of plant material (identifying organic ideotypes for local conditions, and breeding), establishment of productive, resistant and competitive canopies, rotations and technology suited to N-fixation, green manuring and fertilisation by organic materials recycled from the food system and weed control are among the key issues under this topic. The need to fix the

required N within the system inevitably requires an overall increased legume production. Unfortunately, legumes are subject to many severe disease and insect problems and overall the genetic resources of legumes are currently underused.

There is a need to carefully evaluate the usefulness of single topic projects. The systems approach of many of the projects could be completed by closely tying together crop production and crop protection with genetic resource development and also by integrating animals into the system. Overall, the projects need to be evaluated for the economic and social implications as the success of new strategies will depend on the practicability and economic framework.

Because of the multitude of restrictions, there are specific types of research that need to be focused upon:

Making nutrients available at the right time. This can be done via rotations, green manures, composts and other fertility-building treatments, including improving legume production. The effects of crops on the whole rotation need to be looked at to avoid the accumulation of problems rather than focusing on the maximisation of a single commodity. For example, maize is known to increase *Fusarium* and mycotoxin problems in subsequent wheat crops. Also, the effects of organic amendments often cannot be evaluated in the short term. Rather, two or three subsequent seasons need to be evaluated to determine overall effects. Special importance has to be directed to the effects of the amendments on the microbial community (see below).

Plant breeding should concentrate on nutrient efficiency with respect to organic nutrient management. Work on legume resistance to pathogens and insects is of particular interest whilst the integration of legumes, animal health and production aspects is innovative and should be supported.

Weed management. Besides nutrient management, weed management is one of the most important topics in organic plant production. The heavy use of the plough and most of soil tillage is geared towards weed management, but (a) this is an energy intensive approach that may not be appropriate in the future and (b) soil conservation and soil fertility are often negatively affected by tillage practices. Weed management can only be dealt with within the system, considering the rotation over time and the crop species, planting arrangements and

varieties available (competitiveness, planting time, allelopathy). In addition, there is a need for innovative energy efficient and light-weight equipment that reduces the harm to the soil through mechanical management as much as possible.

Enhancing soil microbial activity to enhance soil health and effective microbial treatments. The functionality of the soil microbial community must be a top priority, as discussed in the topic Soil and Nutrient Management. Research on the effects of processing methods of organic waste and composition of composts is very important. For example, depending on the composition of the organic amendments, cellulolytic or chitinolytic pathways within micro-organisms such as *Trichoderma spec.* may be favoured, influencing the potential for biocontrol activity in the soil. Generally, research in soil microbiology is of great relevance to plant protection and care should be taken that a component dealing with plant health, i.e. the functionality of the soil microbial community with respect to disease suppression, is added to such projects.

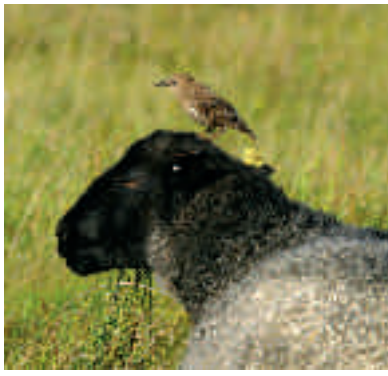
Little progress can be expected from microbial treatments of above-ground plant parts in the field, as variability and unpredictability in environmental conditions is large. In addition, the development of such treatments generally is rather expensive. Thus, for microbial treatments to be successful, they must concentrate on high-value crops and be applied under more controlled conditions, i.e. to the soil or under greenhouse conditions. Besides the development of microbial treatments, an interesting approach to biocontrol is the use of endophytes. This might have the potential for effective biocontrol with little dependency on the environment.

Innovative approaches to plant resistance and habitat management. Resistance breeding should concentrate on diseases that cannot be managed with rotations and on crops for which there is sufficient market potential for commercialisation. In addition, the focus should be on resistances that are likely to be durable and that integrate into the agricultural system. Inducibility of resistance to pathogens, associative resistance to insects (e.g. plant-plant communication), allelopathy to weeds and pathogens, and competitiveness to weeds may be appropriate targets. While habitat management may also include the use of resistance, a main aspect to be considered is scale. It is very important to make clear that scale will always affect the functioning of a given approach. Inoculum

load and migrational patterns are strongly affected by scale, and with respect to biodiversity, it is the landscape structuring and limiting of size that usually turns out beneficial independent of the farming system.

Bioenergy. The Panel accepted that energy use is an important issue in society, as oil price has risen and stocks are diminishing. Organic farming systems could be modified to make them self-sufficient for energy by the production of bioenergy crops. Such a development would be in line with the philosophy of organic farming and produce systems with high sustainability. Whilst the panel agreed that production of bioenergy was an important research topic for agriculture more generally, opinion was divided as to the emphasis that should be put to this topic in a programme directed specifically to organic farming, because these systems generally already have higher energy economy than conventional production systems. The good energy economy of organic farming is mainly due to reliance on biological N fixation, rather than on N fertilisers. The absence of use of N fertilisers also contributes to lower greenhouse gas emissions. With these problems being less in organic than in conventional farming, there is greater opportunity to allocate research funds in the organic sector to product system (food system, or commodity system) research. Success in this research will encourage greater adoption of organic farming and along with this the probability of improved energy use and reduced greenhouse gas emissions overall.

Animal production, health and welfare

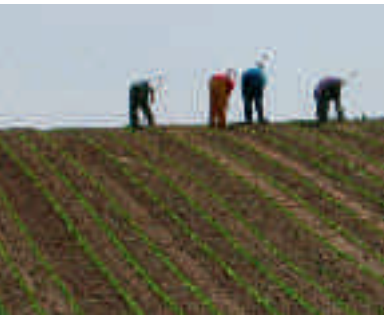


It would appear that the basis has already been provided for reasonably efficient ruminant systems that can operate within organic rules. These will be based on the use of forage legumes; reasonably well-adapted legumes are available for most of Sweden and suitable techniques are available for conservation as silage. There is though a substantial challenge to satisfy animal requirements from home-produced feeds with a high forage component and to minimise the use of animal health products. There are important questions on (a) the feeds to use (in relation both to energy and protein supply), (b) the animal type to use and the required level of milk production, (c) the best way of sustaining production during grazing and (d) the ways in which whole systems can be evolved which are economically successful, conform to organic rules and involve low losses of pollutants to water and the atmosphere.

There is a requirement and opportunity for good quality internationally competitive research on animal genetics in relation to organic systems and for research on the effects of feeds and nutrition on animal health. With the possible exception of work on tannin-rich legumes in relation to nutrition and control of helminths, it is not clear that the research in Sweden is at the forefront in these areas. In contrast, the work that is needed on feed production, forage utilisation and on production systems is probably adaptive research, exploring and developing possibilities in the context of Sweden and similar climatic areas. There are well-established research groups in Sweden in this area, particularly dealing with feed supply and conservation, nutrient utilisation and dairy production systems. There is good potential for Sweden to play a prominent part in Nordic and EU programmes relating to organic dairy systems. It is crucial though that the research is carried out within the context and constraints of organic production.

Two important areas are missing in the research on monogastric production. There are requirements to develop systems for pig finishing on pasture and for organic egg production at the farm scale. Previous egg production research has been conducted under rather artificial conditions.

Animal health and welfare is extremely important for the image of organic food products in general in the western world and the Swedish researchers in this area are producing good results. There are many problems, which require to be addressed by research and the current expenditure on research in this area seems quite moderate in comparison with other subtopics. A specific topic, which may need more attention, is mastitis control in dairy production.



Socio-economic aspects of organic farming

The main recommendation for socio-economic research on organic farming is that more needs to be done but not necessarily "more of the same". Future research should first of all include the topics that were listed in the previous Formas call but have so far were not been sufficiently addressed in the research carried out. Also, socio-economic research should be more effectively linked with component research in a systems context.

In future research calls, funding agencies should give priority and emphasis to economic and policy research topics including marketing and institutions. There could be two main

areas. Firstly, future priorities should more directly address questions arising from the producer-retailer-consumer interaction in terms of management, logistics, information technology and product quality. This theme is particularly important in view of the Government's policy to increase the market shares of organic food products. Secondly, topics related to policy research and spatial analysis of the impact of the large-scale diffusion of organic farming in Sweden are of high priority. This needs to effectively link micro, meso and macro level considerations and include the valuation of ecosystems services. It would be particularly important for such work to be carried out in integrated research groups rather than in small individual projects. One important public good provided by farming is the biodiversity associated with agricultural land use. It is important that there is continued funding of research on the impacts of organic farming on biodiversity, particularly at the landscape and regional scale. Successful projects have already been carried out on this subject in the reviewed programme (see Crop Production and Protection), indicating that high standards can be achieved in this area.

To enhance socio-economic research in organic farming to the level that will be necessary, there probably needs to be some stimulation of the supply side of socio-economic research. Economic research in Sweden, especially in the field of environmental economics (and forestry economics), is widely recognised but some of these strong groups do not appear to have been involved in this programme. In order to increase the efficiency and impact of the research, it would be important to seek involvement of such groups. The Panel encourage the funding bodies to take a more proactive approach in seeking participation of high-class researchers in integrated research groups.

Type of future programme

We recommend that the future programme pays particular attention to three aspects:

1. Research on marketing, production and resource economic questions, as well as policy and social issues relating to organic production. We endorse the topics in this area that were included in the research calls from Formas, but they do not appear to have stimulated a full response from the research community. There are no projects in some areas and many of the projects funded do not appear to have addressed key issues. The requirements remain and are of increased importance

with the growth of the organic sector. ***It is recommended that research sponsors take a proactive approach to engage with the research community in this area to increase their familiarity with the research requirements and funding possibilities.*** Such efforts may also explicitly be addressed to researchers outside the realms of the agricultural sciences and invite, for example, collaboration from environmental economists, where Sweden has high international reputation. Requests for expressions of interest and possibly invitations to tender may produce better results than an open call.

2. Integrated research on systems of production considering production, economics and the environment. Organic production with its strong dependence on farm and common property natural resources is essentially an integrative activity with strong interactions between the different components of production and accent on long-term system sustainability.

As a single example of the interactions and complexity, the population and feeding regime of animals will determine the quantity and composition of manures produced, the nutrient availability of which will be influenced by methods of storage and application. Different strategies for manure use can be followed, dependent on the cropping system at the farm level. The strategy followed will not only affect crop growth and quality, but also influence crop susceptibility to pests and diseases and weed ingress, the quantity of N fixed by legumes and thus the quantity of N available to support the whole system. These factors will determine the losses of nutrients to the environment and thus modify the feed available for livestock production and the level of stocking that can be sustained. Intervention at any point during this sequence will have potential impact throughout. Furthermore, the way that the animals are kept and fed will affect product quality and perceptions of animal well-being and thus impact on possible marketing strategies.

Whilst previous calls have stressed the need for an inter-disciplinary approach and some projects in the previous programmes have approached issues at a systems level, most of the effort has been directed to components of systems. The Panel believes that there is now an increased requirement for integrated projects at the systems level that are inter-disciplinary, include both strategic and applied work and address issues relating to production, economics and the environment. Such projects are demanding both to develop and to manage and

would often be larger than those normally funded by any of the funding bodies. We are encouraged by the fact that a high proportion of the large projects funded in the reviewed programme came up to high international standards and consider that the Swedish research base has the strength to tackle these integrative opportunities.

The Panel were attracted to the approach of CUL in providing limited funds for developing project bids. This could be particularly important in evolving the complex and often multi-institutional bids required for this approach. CUL may be in a good position to take a pro-active approach to assemble consortia to bid in project areas that have been identified for support by the funding body. It may also be appropriate for some such projects to involve a combination of funding from different bodies and to have duration longer than three years. Clearly relatively few large projects of this type could be funded at any time. We would not wish to be proscriptive, but projects could focus on particular important types of organic production systems or on the efficient use of a resource, such as energy.

3. Component research on some of the key processes underpinning efficient organic farming. Whilst we encourage the allocation of a higher proportion of research funding to areas 1 and 2 above, there are still many important requirements for component research on key aspects of organic systems. Requirements are indicated in the reports on different topics. The Panel stresses that in order to ensure relevance, the research at the component level, must be planned within the context of the organic system.

Promotion of Swedish Research

The Panel were impressed with the extensive facilities in Sweden for organic research and the examples of excellent projects in the projects reviewed. We felt though that this research had not yet achieved high recognition outside of the country and that efforts should be made to make this research more visible internationally. Many teams had developed good international linkages, but there were others where better international contact would have benefited the research. We believe that increase in the visibility of the research would benefit organic production more widely in Europe and also provide benefit for Swedish research through forging more collaborations and linkages.

There will be good opportunities for collaboration through European initiatives, such as the CORE Organic programme, and through Nordic programmes. It will be important for Sweden to continue to play a full part in such initiatives. The profile could also be increased by hosting more international conferences or workshops in Sweden on aspects of the science of organic production and involving international scientists more in the coordination work of CUL.

Management of Research Programmes

Whilst many of the projects produced excellent outputs, the Panel were concerned that the proportion of projects giving rather poor outputs was higher than we had expected. This was particularly the case for the poor output of refereed publications. There were indications that the Swedish research community may not have treated this international appraisal of research as seriously as it warranted. Reports were not obtained for a substantial proportion of the eligible projects. The detail provided in the project reports was poor in a significant proportion of the reports, with lack of information on what research was carried out and some sections not being completed. There were also difficulties in obtaining copies of refereed papers for consideration by the review team.

There is need to consider actions that could be taken to bring more of the projects up to the level of the top third and thus enhance the efficiency of the overall programme. The outstanding weakness in the reviewed programme was the limited output of refereed journal papers. The Panel found this very difficult to understand, because the policies of Formas, in particular, have very much encouraged a publication culture and PhD theses are normally, built around a series of papers submitted to refereed journals. Also, most of the PIs appeared to have good records of publication. With effective publication, our assessment of the overall programme would have been higher.

We discuss below the procedures for project selection, review and reporting and make recommendations for some changes in these procedures.

The call. We thought that generally the calls from the funding bodies were appropriate, although there may be a case for narrowing the focus somewhat to increase the probability that projects would come forward in the most important areas. Comments on the particular needs to encourage high quality work in the socio-economic area and for the support of large integrative projects were made above.

Project applications. In order to provide an early focus on what should be produced from a project, ***we recommend that the application forms include milestones and deliverables***, as in the case of many EU projects. ***We recommend that all project proposals are written in English and appraised both by Swedish and international reviewers.*** It may be appropriate to make increased use of referees from outside the Nordic countries. Clearly the track record of the proposer for delivery should be an important factor in the selection process.

Review of on-going projects. There is a need to more strongly encourage a culture of monitoring and impact assessment amongst both researchers and funders. The system of annual appraisal followed by SJV and SLF should provide adequate monitoring. ***We recommend that consideration be given to the production and review of some form of status report annually for all projects.*** This can be linked easily with milestones and deliverables in the project application and need not be unduly time consuming either for the PI or the funding body.

Appraisal of projects on completion. More formal evaluation of the final reports on projects should be carried out. ***We recommend that, particularly for projects funded by Formas, peer review is carried out on final project reports.*** This would provide a continuing source of quality control for individual projects and the programmes. Some form of recording and monitoring of the published outputs subsequent to the submission of the final project reports would also be useful.

Project responsibility. Although projects are formally with an organisation rather than an individual, the culture and procedures in Sweden seem to give the prime responsibility for delivery to the Principal Investigator rather than to a Department or Institution. In quite a number of projects, the progress of the research was severely delayed because of illness or leave for the Principal Investigator. This provides real difficulties for field research, which requires continuity and for the progress of research on urgent problems. We feel that following this procedure was also a major factor leading to the absence of project reports and the rather casual nature of the reports produced by others. Individuals had moved on to other things and reports on work carried out some years ago did not appear to be high on their priority lists.

Some other countries (e.g. Germany and UK) lay the responsibility for a project much more centrally with the organisation rather than the individual. In that case the organisation accepts the problem of producing a solution should the original PI not be able to continue the project and also accepts responsibility for the delivery of effective project reports. We believe that this alternative model should be considered further in Sweden. ***We recommend that the funding bodies consider actions that may be taken to increase the institutional responsibility for the conduct and reporting of projects.*** It would be particularly important for ensuring the management and continuity of the larger integrative projects that we seek to encourage. Such projects would involve the efforts of several research scientists and in many cases make extensive use of resources.

Summary of Recommendations

1.There is continued substantial commitment of research support to the organic sector (p. 71).

2. There is continued ear-marked funding for this area and that the research should be carried out within the context of organic farming rather than under the more general umbrella of sustainable farming systems (p. 71).

3. The future programme pays particular attention to three aspects: (a) Research on the social, economic, marketing and policy issues relating to organic production. (b) Integrated research on systems of production considering production, economics and the environment. (c) Component research on some of the key processes underpinning efficient organic farming (p. 77–79).

4. The research sponsors take a proactive approach to engage with the research community in the area of socio-economics to increase their familiarity with the research requirements and the possibilities for funding (p. 78).

5. Project applications should include milestones and deliverables and all project applications should be written in English and appraised both by Swedish and international reviewers (p. 83).

6. Consideration should be given to the production and review of some form of status report annually for all projects (p. 83).

7. Peer review is carried out on final project reports, particularly for projects funded by Formas (p. 83).

8. The funding bodies consider actions that may be taken to increase the institutional responsibility for the conduct and reporting of projects (p. 84).

9. A separate evaluation is carried out on the Research Schools and their success in delivering their objectives (p. 69).

Part 2.
Relevance and Utility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Part 2. Relevance and Utility

Summary

In January 2006 the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), the Swedish Board of Agriculture (SJV), the Swedish Farmers' Foundation for Agricultural Research (SLF) and the Swedish University of Agricultural Sciences (SLU) EkoForsk charged a scientific evaluation panel with evaluating research programmes concerning organic production, based on the relevance and utility of the projects involved for farmers and agricultural advisors. The evaluation periods were 1997–2004 for projects financed by Formas and SLF, 2000–2004 for projects financed by SJV, and 2002–2004 for projects financed by SLU EkoForsk.

The Evaluation Panel consisted of four Nordic agricultural advisors and one agricultural journalist. Evaluation was based on returned report surveys which were distributed to the researchers in charge of the projects. The Panel had very limited opportunities to obtain any additional information within the financial and time framework to which the evaluation work was subject.

This report presents the Evaluation Panel's results, broken down into five subject areas (Soils, Crops, Livestock, Horticulture, and Systems and Landscapes), and broken down according to the funding body (Formas, SJV, SLF and SLU EkoForsk).

The general objectives of the four funding bodies differ somewhat. The biggest financier in this context (Formas) focuses strongly on sustainable development, and the projects in its programme conform on the whole to the overall objectives set. With respect to meeting government goals for organic production, which serve as the basis for the research programme, there is however a need for a more holistic approach and a better focus on the relevance of the research to practitioners in the area of organic production. The other three funding bodies take approaches that are more practical in their research programmes. The prioritisations of the areas of research were, however, deficient in a number of these cases.

The bulk of the research has been conducted within the framework of smaller research projects, known as "component research", even though larger, more broadly based projects are also present. The need for a more holistic approach is highlighted in the evaluation at the subject area level. The group also notes that there are important elements in the programme areas that were not taken into account in the projects that were available for evaluation.

In those programmes in which the research aims have been defined through communication with agricultural advisors, government agencies and researchers, the work has proved to be particularly relevant to the needs of industry.

With regard to the future, the Panel stresses the importance of intensified research cooperation with practitioners in the area of organic agriculture. Because organic production involves working with entire systems, the cooperation of representatives from the world of organic production who are familiar with such systems is essential at the stage when the research programmes are being designed and formulated. We recommend that those who assess such projects and award funding should possess expertise in organic production, so that they have knowledge of the existing problems in the production process. Suggestions from the Evaluation Panel:

- closer cooperation between the funding bodies
- greater expertise in current organic production when evaluating project applications
- cooperation between researchers in various disciplines, and a problem-oriented working method
- cooperation between purchasers and researchers throughout the entire research process
- researcher communication with farmers and agricultural consultants should be taken into account as a qualifying factor
- an overall research strategy for research on organic production and, thus, continued earmarked funding for such research

The Panel recommends that the present level of advisory services in Sweden be maintained in order to bridge the information gap between the research and its users.

Sammanfattning

I januari 2006 gav Forskningsrådet för miljö, areella näringar och samhällsbyggande (Formas), Stiftelsen lantbruksforskning (SLF), Jordbruksverket (SJV) och SLU EkoForsk uppdraget att utvärdera finansiärernas forskningsprogram avseende ekologisk produktion. Fokus på utvärderingen skulle vara forskningens relevans och nytta för jordbrukare och rådgivare. Utvärderingen gällde perioden 1997–2004 för de projekt som finansierats av Formas och SLF, 2000–2004 för projekt som finansierats av SJV, samt 2002–2004 för projekt som finansierats av EkoForsk.

Utvärderingsgruppen bestod av fyra nordiska lantbruksrådgivare och en lantbruksjournalist. Utvärderingen har grundats på inlämnade översikter från de forskare som har varit projektansvariga. Gruppen hade mycket begränsade möjligheter att skaffa ytterligare information inom den utsatta tiden för utvärderingsarbetet.

Rapporten presenterar utvärderingsgruppens resultat uppdelad på fem ämnesområden (mark, växt, husdjur, trädgårdsbruk samt system och landskap) samt även uppdelad på respektive finansiär (Formas, SLF, SJV och SLU EkoForsk).

De fyra finansiärernas målsättningar skiljer sig ganska mycket från varandra. Forskningsrådet Formas, störst av de fyra, har starkt fokus på hållbar utveckling, och projekten i Formas program överensstämmer i huvudsak med de uppställda målen. När det gäller uppfyllelsen av regeringens mål för ekologisk produktion, som utgör grunden för forskningsprogrammet, finns det dock behov av ett mer helhetsbetonat synsätt och större fokus på forskningens relevans för praktiker. De tre övriga finansiärernas forskningsprogram är mer praktiskt betonade, men prioriteringen inom forskningsområden var bristfällig i flera fall.

Huvuddelen av forskningen har genomförts inom ramen för mindre forskningsprojekt, även om det dessutom har finansierats större och bredare projekt. Behovet av ett mer helhetsbetonat synsätt tydliggörs. Gruppen noterar även att det finns

viktiga programdelar som inte har beaktats i de projekt som har utvärderats.

I de programområden där syftet med forskningen har definierats genom kommunikation med lantbruksrådgivare, statliga verk och forskare har arbetet varit synnerligen relevant för den ekologiska produktionen.

När det gäller framtida utlysningar understryker gruppen betydelsen av fördjupat forskningssamarbete med praktiker inom det ekologiska jordbruket. Eftersom ekologisk produktion är ett system där det krävs helhetstänkande, är samarbete väsentligt när forskningsprogrammen utformas. En rekommendation är att de som granskar projekten inom området har bred kunskap om de existerande problemen i produktionsprocessen.

Utvärderingsgruppen har följande förslag:
• närmare samarbete mellan finansiärer
• bredare expertis i aktuell ekologisk produktion när projektansökningar granskas
• samarbete mellan forskare inom olika kunskapsområden, samt en problemorienterad arbetsmetod
• samarbete mellan finansiär och forskare genom hela forskningsprocessen
• kommunikation mellan forskare, jordbrukare och rådgivare bör ses som meriterande
• en övergripande forskningsstrategi för forskning om ekologisk produktion och en fortlöpande öronmärkt finansiering av denna forskning

Gruppen rekommenderar att rådgivande tjänster i Sverige bör behållas på nuvarande nivå för att överbrygga informationsklyftan mellan forskningen och den ekologiska produktionen.

Background

Four Nordic agricultural consultants and one agricultural journalist were charged by the Swedish Research Council for the Environment, Agricultural Sciences and Spatial Planning (Formas), the Swedish Board of Agriculture (SJV), the Swedish Farmers' Foundation for Agricultural Research (SLF) and the Swedish University of Agricultural Sciences (SLU) EkoForsk with evaluating organic production research programmes in terms of their relevance and utility for farmers and agricultural advisors. The evaluation was conducted during the spring of 2006. The Evaluation Panel based its work on survey responses from the project managers, and on the four funding bodies' research programmes.

The purpose of evaluating relevance and utility was to assess how current production issues were taken into account in the research projects that had been granted funding during the reviewed period. The total impact of the investments at the programme level was evaluated, rather than the individual projects involved.

In Formas' research programme concerning organic production (Appendix 1) there is an emphasis on the highest scientific quality and sector relevance, and on ensuring that the connection between theory and practice is evident. The research community is invited to submit proposals regarding the content of this programme.

The programme included no projects concerning energy or waste management.

SLF has no special programme for organic production, but has chosen to permit the evaluation of those projects they consider to be of particular interest in terms of organic production, and which were granted at least SEK 200,000 in project funding during the period studied, 1997–2004.

The Swedish Board of Agriculture (SJV) formulated a framework programme in 2000 for "Decreased risks from biocides,

the environmental impact of nutrients, organic farming and biological diversity" (Appendix 2). The purpose of funding this framework programme was to create a number of projects to address current, concrete and pressing environment issues in the area of agricultural production.

SLU EkoForsk states that its aim is to increase the amount of arable land in Sweden that is cultivated organically by funding field experiments to solve limiting factors. The funded research must be of high scientific quality, and must generate scientific articles and materials that can be used by advisors. The projects must be highly relevant to organic business and commerce. The projects can be one-, two- or three-year projects.

The number of completed projects, broken down by subject area and funding body, is presented in Table 12, while the funding awarded is presented in Table 13.

Table 12. Number of projects broken down by subject area and funding body.

	Soils	Crops	Livestock	Horticulture	Systems and Landscapes	Total
Reported projects						
Formas	10	8	7	7	9	40
SJV	3	7	9	8	1	29
SLF	3	3	4	0	3	13
SLU EkoForsk	1	8	0	3	1	13
Co-financed	2	2	3	1	2	10
Total	**19**	**28**	**23**	**19**	**16**	**105**
Unreported projects						
Formas	0	1	6	3	1	11
SJV	0	3	2	1	1	7
SLF	1	7	0	1	1	10
SLU EkoForsk	0	0	0	0	0	0
Total	**1**	**11**	**8**	**5**	**3**	**28**

Table 13. Granted funds broken down by subject area and funding body, in MSEK.

	Soils	Crops	Livestock	Horticulture	Systems and Landscapes	Total
Reported projects						
Formas	16.8	12.7	15.4	12.1	20.6	77.6
SJV	7.4	14.0	10.9	5.8	2.0	40.1
SLF	1.0	0.8	2.6	-	1.9	6.3
SLU EkoForsk	0.6	8.8	-	2.9	0.4	12.7
Co-financed	3.5	8.4	20.0	13.0	2.8	47.7
Total	**29.3**	**44.7**	**48.9**	**33.8**	**27.7**	**184.4**
Unreported projects						
Formas						28.6
SJV						10.7
SLF						10.6
SLU EkoForsk						0
Total						**49.9**

The Evaluation Panel and the Evaluation Process

Niels Finn Johansen, Soile Wartiainen, Grete Lene Serikstad, Kerstin Holmström and Michael Tersbøl.

The Evaluation Panel had five members:

Kerstin Holmström, Borgå, Finland: MSc in agriculture, agricultural journalist and translator. Many years of professional experience in the agricultural press, advisory work, and agricultural education in Finland.

Niels Finn Johansen, Skejby, Denmark: MSc in agriculture, national advisor on egg and chicken production at the Danish Agricultural Advisory Service at the National Centre.

Grete Lene Serikstad, Tingvoll, Norway: MSc in agriculture, advisor at Bioforsk Økologisk.

Michael Tersbøl, Skejby, Denmark: MSc in agriculture, national advisor on organic farming at the Danish Agricultural Advisory Service at the National Centre. Chief coordinator of organic field experiments in Denmark.

Soile Wartiainen, Åland, Finland: MSc in agriculture, advisor for organic production in Åland, employed by Pro-Agria, Åland's Rural Economy and Agricultural Society.

Evaluation process

The Evaluation Panel were instructed to consider four questions:

- Did the research activity have objectives that were relevant to the development of organic production?
- Has the research led to new knowledge of significance to the development of organic production?
- Has the research enhanced the capacity of the advisory services to provide answers to current questions in the area of organic production?
- Have the results been made available to various interest groups in a satisfactory manner?

As the documentary basis for their evaluation, the reviewers had access to the funding bodies' research programmes, framework programmes, guidelines for evaluating R&D programmes and information concerning the individual projects, as provided by the project managers. 140 projects were included in the evaluation process, and information concerning 105 of them was received from the project managers. The evaluation group had no opportunity to obtain supplementary information about the project results, nor information concerning the complete distribution of those results. The group's evaluation is based on the materials placed at its disposal for evaluation purposes.

All the individual projects for which information was received from the project managers were evaluated based on four criteria:

- *Objectives:* do the project objectives correspond to the funding bodies objectives?
- *Relevance:* does the project have relevance for agricultural advisors and farmers?
- *Dissemination:* have the results from the project been disseminated to agricultural advisors and farmers?
- *Capacity building:* has the project produced new and relevant information for agricultural advisors and farmers?

The projects were rated using a four-point scale:

1. Weak/Low
2. Somewhat unsatisfactory
3. Satisfactory
4. Good

The results of these assessments have been broken down by subject category (Soils, Crops, Livestock, Horticulture, and Systems and Landscapes) and by funding body (Formas, SLF, SJV and SLU EkoForsk).

Results broken down by subject area

Soils

The subject area "Soils" comprised a total of 21 projects in the Evaluation Panel's breakdown. For one of these projects no report was submitted. Two of the projects were combined in the evaluation, so that Table 14 covers 19 projects in all. A total of three masters' students and one doctoral position were associated with the projects.

Five of the projects lasted up to two years, while 13 of them lasted between three and five years. One project lasted seven years. The fact that most of the projects extend over several years is advantageous. Many of the issues germane to soils require several years of field experiments because the effects of various treatments often only become apparent in the long term.

Nine of the projects were relatively small, with grants of less than MSEK 1. Six of the projects received funding amounting to between MSEK 1 and 2, while only four projects were granted more than MSEK 2.

Although funding was intended for organic agriculture, it is apparent that several of the projects dealt with problems relevant to agriculture in general, rather than being specifically focused on organic agriculture.

There is a large spread in terms of whether the projects addressed themes relating to basic research or to more applied research. Several of the projects dealt with basic themes, and

Table 14. Scores for R&D projects in the "Soils" category.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	2	4	6	7	3.0	1.0
Relevance	2	2	7	8	3.1	1.0
Dissemination	9	7	1	2	1.8	1.0
Capacity building	3	7	7	2	2.4	0.9
Total	**16**	**20**	**21**	**19**	**2.6**	**1.1**

their results have not led to practical benefits for practitioners. These projects will be relevant to practitioners only in the long term.

Only one of the project reports indicated that an agricultural advisor had participated in the project, and none of the projects appears to have involved a farmer/grower. The participation of advisors and/or farmers/growers via, e.g. a reference group that is part of the project organisation can ensure relevance and utility for practitioners.

The projects in the "Soils" category break down by funding body as follows: Formas ten projects, SJV four projects, SLF five projects and one jointly financed project, and SLU EkoForsk one project and one jointly financed project.

Formas
Formas financed ten "Soils" projects.

Objectives
Half of the projects were consistent with Formas' objectives for research on organic agriculture. In our view, the other five projects only conform to a limited extent with the objectives set by Formas. Some of them were started prior to 2001, making it difficult to evaluate them based on the framework for the research programme from 2001. Several of the projects address general agricultural topics rather than those specific to organic agriculture.

Cultivation system ecology
This theme was covered by both the "Soils" and "Crops" projects. The "Soils" projects mostly address problem to do with individual soil organisms, such as mycorrhiza, and deal only to a limited extent with more general and comprehensive issues.

Technical-biological systems
Biological subsoil loosening and issues concerning compost were addressed in all three projects. The supply of plant nutrients is addressed in several projects. Little attention is paid to technical solutions, or to the connections between technology and biology/ecology.

Multifunctional agricultural systems were not addressed in any of the projects included in this evaluation. Two projects addressed analytical methods for phosphorus.

Turnover of the nutrients N, P and K was addressed in several projects, but none of the other nutrients specified in the research call were studied. Non-livestock systems, green fertiliser and minimising nutrient loss to the environment were not addressed in the "Soils" projects.

Relevance
The projects varied greatly in terms of their relevance to advisors and farmers in organic agriculture. Seven of the studies have good or very good relevance to consultants and growers, e.g. two projects about soil cultivation have very good relevance. Some of the projects addressed problems that were relevant in the short term, others in the somewhat longer term, as they constituted more basic research, while others were less relevant. Projects studying pesticides and cadmium pollution of the soil in connection with the use of mineral fertilisers are of little relevance to organic agriculture.

Dissemination
Unfortunately, the dissemination of results to advisors and farmers was generally weak or somewhat unsatisfactory. In our opinion, only one project exhibited satisfactory or good distribution of its results to practitioners. The channels available for the verbal or written dissemination of results to these groups were not utilized in the other projects.

Capacity building for distribution to practitioners
Most of the projects resulted in only a limited dissemination of relevant information to advisors and farmers. Some of the projects are more concerned with basic research, and their results cannot be applied immediately.

Two projects did contribute important and useful knowledge to practitioners to a particularly large degree. One concerned biological subsoil loosening prior to a changeover to organic farming. This project found new and concrete answers to relevant problems. The other research project was on quantifying the contribution of weathering to crops' potassium supply in different agricultural soils. This project provided useful knowledge about potassium supplies from various soil types. Investigating such topics requires long-term field experiments, and the fact that existing fields were used is an advantage. This project has been widely publicised by word of mouth.

SJV
SJV funded four "Soils" projects.

Objectives
The topics for these projects fall within the criteria established by the Swedish Board of Agriculture. Most of the projects deal with plant nutrients, particularly nitrogen. Minimisation of nutrient loss and nutrient supplies in systems with and without livestock were also addressed. However, the projects did not cover all the themes identified by the Swedish Board of Agriculture.

Relevance
These projects have good relevance for advisors and farmers. In this regard the level of relevance is, probably, better than the relevance with respect to SJV's own objectives.

Dissemination
Unfortunately, the dissemination of results to advisors and farmers was not particularly extensive for any of the projects. There is much to indicate that information about some of the projects has not been fully disseminated.

Capacity building for practical application
The projects have generated relevant knowledge, but the potential to disseminate this knowledge has not been exploited. In particular, one project concerning poultry manure yielded new knowledge of importance. Results relating to several of the research topics have been published previously, partially in other Nordic countries with roughly comparable conditions. Relatively large sums of money were spent in some of the projects in relation to the results achieved.

SLF
SLF funded five of the "Soils" projects, and jointly funded another project. For one of the projects no report was received.

Objectives
The projects meet SLF's objectives in the areas of plant protection and nutrient turnover. Some of the projects address the cultivation of cereals, which is one of the three main areas that were specifically identified.

Relevance
The results from the projects are relevant for advisors and farmers, but many of these projects concern to basic research. The results have not yet led to any practical applications and it may take time before the project results can be used in practice.

Dissemination
The dissemination of results to advisors and farmers was weak in the case of three of the projects. On the other hand, the results from a project concerning "Grassland potassium supply in an organic system and a conventional system" illustrated good and well-rounded dissemination of a relevant issue to advisors and farmers, both verbally and in writing.

Capacity building for practical application
Some of the projects have resulted in new and relevant information for advisors and farmers. Others tend more toward basic research, and it will therefore take time before their results can be applied in practice.

SLU EkoForsk
SLU EkoForsk funded one project and jointly funded another in the area of "Soils".

Objectives
These projects are helping to eliminate bottlenecks in organic agriculture, and fall under the headings of optimising production systems without livestock and turnover of plant nutrients, respectively. These projects therefore favourably meet the objectives stated in the research call.

Because the research call is so sweeping and largely abstract, it is almost impossible to identify the specific subject areas which should have been covered, but for which funds were not granted.

Relevance
The research topics in both projects are highly relevant for advisors and farmers. The fact that long-term experiments have been used is an advantage.

Dissemination
The dissemination of results to advisors and farmers has been good, especially verbally. The use of written publications directly targeting farmers/growers through journals and advisory material could have been better. However, the publication process has not been completed.

Capacity building for practical application
Some of the data were known previously, but the projects have still undoubtedly provided new and relevant information for advisors and farmers.

Crops

The combined research calls from the four funding bodies are very broad, and compliment each other well. The most focused and, at the same time, widest-ranging framework is from SJV. The least focused and thus most open framework is from SLU EkoForsk, which can accommodate nearly any aspect of crop cultivation if it constitutes a relevant bottleneck. The Formas framework comprises many themes and covers a broad range, but does not seem as precise or concrete. SLF's framework is broad and abstract, and can encompass projects that target agriculture in general, rather than just organic agriculture. The project scores are presented in Table 15.

Table 15. Scores for R&D projects in the "Crops" category.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	3	7	18	3.5	0.7
Relevance	2	3	7	16	3.3	0.9
Dissemination	6	6	7	8	2.5	1.1
Capacity building	2	8	13	5	2.7	0.8
Total	**10**	**20**	**34**	**47**	**3.1**	**1.0**

Formas

Meeting objectives and relevance

Formas' projects fall within the following themes in Formas' framework/research calls.

- Ecology of cultivation systems
- Technical/biological systems for organic agriculture and horticulture
- Turnover of plant nutrients
- Food – quality and health

Within "Ecology of cultivation systems" there is a central question under which Formas' projects can be classified:

- How can problematic weeds, plant diseases and pests be controlled? To answer this question, Formas is seeking "general knowledge concerning the dynamics of weeds and pests in the cultivated landscape", including the influence of cultivation methods and the appearance of the landscape.

Four Formas projects, which concern weeds, pests and plant diseases, fall within the ambit of this main question. These projects received average scores in terms of fulfilling Formas' objectives because while, on the one hand, they come under

the research call for "general knowledge", on the other hand, they are highly specific to their fields and do not include landscape and population dynamics factors as requested.

The projects scored relatively poorly in terms of relevance, as the problematic pests being focused on are not considered, in practice, to be sufficiently problematic in a larger context.

Two projects under the respective headings "Technical/biological systems for organic agriculture and horticulture" and "Food – quality and health" scored relatively highly for both meeting objectives and relevance, as these topics are more germane to the Formas framework, and the focus is on problems that are important in agriculture.

Finally, three projects under the heading "Turnover of plant nutrients" had an average score for meeting objectives and relevance because they are not directly related to the research topic specified in the framework, and because the issues dealt with and their relevance are limited. A final project under the same heading scored well, as it addresses a very topical problem (high relevance) and fits well into the Formas framework.

Dissemination

Two out of the ten projects only submitted "Form 1" (for scientific evaluation), and dissemination to farmers and advisors is not included in this form. As a result, only eight of the Formas projects have been evaluated in terms of result dissemination. However, the possibility cannot be ruled out that results from the two projects for which Form 2 is lacking were not actually disseminated to this target group, and that the projects consequently may be classed under "unsatisfactory dissemination".

The dissemination of results to farmers and advisors was inconsistent. In our evaluation there are as many projects that received satisfactory marks as received unsatisfactory marks in terms of result dissemination. The three projects with the worst dissemination were also those with the least relevance. It is therefore only natural that these projects were not of sufficient interest to warrant their distribution to those involved in practical agriculture, and that no dissemination to that target group occurred. For instance, if a project involves very narrow basic research, then the issue and results will presumably be of such academic interest that there will be no point

in writing popular science articles about it. Fortunately, the projects with the most relevance scored highest for dissemination as well.

Capacity building for practical application
The ten Formas projects received average scores for new knowledge and capacity building among advisors. There were thus not many projects that provided decisive new knowledge in terms of ecology and for practical use by advisory services, but neither were there any that offered no new knowledge whatsoever.

SLF
Meeting objectives and relevance
All three SLF projects concern the control of aphids in barley (cereals) and vegetables (parsley and dill) using innovative new methods that do not involve synthetic insecticides. The jointly financed project deals with weed control in row crops using robot technology. All four projects fall under SLF subject areas "Crop protection" and "Horticulture", and have consequently been given relatively high scores for meeting objectives. They also received high scores for relevance, as aphids can be a serious pest in certain crops.

Dissemination
The three projects on aphids received low scores for dissemination, as only researchers were targeted, and no articles were written in Swedish. However, one of the projects has not yet been completed.

Capacity building for practical application
The SLF projects received average scores for capacity building because although they represent work that involves new and innovative methods, to achieve effective capacity building the results need to be more widely disseminated.

SJV
Meeting objectives and relevance
Because the project titles and research topics fall well within SJV's categories and selected topics, all the projects scored highly for meeting objectives.

Two of the nine projects received average scores for relevance, as the problems addressed were not particularly serious and did not restrict production in an organic agriculture. In the

second case the project was relevant in the longer term, but could not be applied in practice in the short term. The other seven projects received high scores for relevance.

Dissemination
Three projects had low or unsatisfactory dissemination, for different reasons. One project generated no publications whatsoever, as it was a pilot project. Another project included presentations for the target group, but no articles. A third project had only research-oriented references. The rest of the projects exhibited satisfactory or good dissemination.

Capacity building for practical application
Only two projects received low scores in terms of new knowledge and capacity building for advisors. This was due in one case to the fact that the project did not have a fully developed concept that could be applied in practice (the pilot project). The other project involved research that had been repeated in other contexts and generated no knowledge to help solve the problems in question. The rest of the projects received satisfactory or good scores.

SLU EkoForsk
Meeting objectives and relevance
SLU EkoForsk has a very broad goal of increasing the area in Sweden under organic cultivation by eliminating limiting factors known as "bottlenecks". In addition there was a general perception that in the period 2002–2004 the lack of organic field experiments under Swedish conditions was one of a number of limiting factors.

Based on this broad goal, it was not difficult to come up with project proposals for SLU EkoForsk, and all of the eight projects we evaluated meet SLU EkoForsk's objectives. All but one of the projects in question scored highly for relevance. One project received a satisfactory score for relevance.

Dissemination
The distribution of results from SLU EkoForsk's plant projects was generally good. Only one project received a score of somewhat unsatisfactory for dissemination, and no product received a weak score. There was one project for which no articles targeting farmers were written. However, the final report has not yet been prepared, even though the project ended in 2004.

Capacity building for practical application
SLU EkoForsk projects scored well in terms of new knowledge and capacity building for advisors. Only one project received a score indicating somewhat unsatisfactory capacity building, namely the same project that received somewhat unsatisfactory marks for dissemination. The "somewhat unsatisfactory" score for capacity building is also attributable to the extremely brief description of the project in the report.

Topics in the Crops category

Table 16. Topics in the area of plant cultivation addressed in the research projects.

	Formas	SLF	SJV	SLU EkoForsk	Total
1. Seed and seed varieties	2		1	1	4
2. Crop protection	4.5	3.5	4.5	1	13.5
3. Arable farming	1		1	4	6
4. Ley farming	1.5		1.5	2	5
Total	**9**	**3.5**	**8**	**8**	**28.5**

1. Seed and seed varieties
Four projects concerned seed and seed varieties. These projects had strong relevance, because choice of variety is an important parameter in farm management. One project concerned improvement through breeding, which although an important area, is also a very large one to cover adequately. For this reason no immediate practical benefits to commercial organic agriculture are to be expected from the project results.

2. Crop protection
Five projects focused on fungal diseases in different crops. Some projects focused on late blight, a very destructive disease, but the results have not led to any new control methods. It appears that choice of variety is still an important method for controlling late blight. One smaller pilot study of induced resistance to late blight leaf mould with the help of aroma extracts looks fairly promising, but we are unable to make an assessment here as to whether the method has been followed up with any additional research.

In the larger context of which diseases are most problematic in organic agriculture, the research efforts received mixed scores. Research on late blight is extremely important, but it has been spread among numerous large and small projects with the result that greater cooperation and coordination could be beneficial. Our impression is that the research call

did not include a process to identify the most serious pests and thereby promote focused research on the most serious pathogenic problems that are limiting production inorganic agriculture.

Four projects addressed aphids. They received relatively high scores for relevance, as aphids can be a major problem in many crops.

Three projects addressing weeds also received high scores for relevance, as they focused in particular on areas where weeds are a major problem: perennial weeds, weeds in row crops, and weed control in crops with poor competitive ability. One project focused on germination delay in annual weed species but received a low score for relevance, as annual weed species and their germination biology are not priority problem areas in practice.

3. Arable farming

The theme of intercropping was addressed in three projects. One project involved very basic research into nitrogen dynamics in systems with intercropping and had satisfactory relevance, even if it was not an area covered by the funding bodies' objectives. Two projects comprised field experiments within the framework of SLU EkoForsk, and scored well for relevance, precisely because the experiments focused on practical cultivation issues. Two projects concerning quality wheat scored highly for relevance, and this theme should continue to be prioritised.

Only one project addressed oil seed cultivation, and there is a continuing need for research on achieving greater reliability in the cultivation of oil seed crops.

4. Ley farming

One project concerned the cultivation of grass seed (ley seed production), and received a high score for relevance. It is important to continue to prioritise this theme.

Four projects were on ley farming and received highly varied scores for relevance. One project emphasised basic research on nitrogen fixation with very little emphasis on practical applications, while the others focused on topics such as species composition in clover grass, mowing strategy, etc. which are of great interest from a practical perspective.

Discussion of topics included in the objectives which were not sufficiently covered:

Cultivation systems
• Crop rotation and nutrient supply in cultivation systems with and without livestock in different regions (SJV)
• Influence of cultivation methods on product quality (SJV)
• Disease problems in legume-rich crop rotations (SJV)
• Cultivation of peaty soils (SJV)
• Improvements in aspects of the cultivation system, such as choice of crop rotation and cultivation methods (SLF)
• Knowledge that can improve precision cultivation in practice (SLF)
• Knowledge that improves control of input and crop quality (SLF)
Cultivation of individual crops/crop groups (all SJV)
• Sugar beet
• Cereals
Organic farming without livestock (Formas)

Reports for the evaluation were not submitted for eleven projects in the "Crops" category. We have only the project titles for these projects, and it is not possible to evaluate the research on such a basis. One project addressed leguminous plant diseases in organic farming, as requested above by SJV. As a result, this topic can be considered to have been covered anyway. Not all the titles are precise or descriptive enough to enable us to determine whether more of the research areas not covered were in fact covered by these projects.

Livestock

The combined research calls from the four funding bodies is very broad, and they compliment each other well. The most focused and, at the same time, broadest framework is from SJV. The least focused and thus most open framework is that of SLU EkoForsk, in which nearly any aspect of livestock production can be accommodated, assuming it constitutes a relevant bottleneck. The Formas framework comprises many themes and covers a broad range of topics, but does not seem as precise or concrete. The SLF framework is broad and abstract, and can encompass projects addressing general agriculture and not just organic agriculture. The composite scores for "Livestock" projects are presented in Table 17.

Table 17. Scores for R&D projects the "Livestock" category.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	3	11	9	3.3	0.7
Relevance	0	2	11	10	3.3	0.6
Dissemination	2	5	8	8	3.0	1.0
Capacity building	1	10	8	4	2.6	0.8
Total	**3**	**20**	**38**	**31**	**3.0**	**0.8**

The projects in the category "Livestock" coincide fairly well with the funding bodies' objectives. Large projects have an advantage over small ones in this evaluation, as multiple goals can be included in large projects and there is room to take a holistic approach and see the context, both of which elements are emphasised by Formas and SJV in connection with their ecology projects.

The projects also score well in terms of relevance. The relevance scores were, however, somewhat unsatisfactory for two of the projects. This was because these projects were not relevant for advisors or farmers.

Some of the projects were not particularly focused on ecology, which lowered their scores.
The projects tended to receive lower scores for "dissemination" and "capacity building" than for "meeting objectives" and "relevance". We have found a lack of dissemination targeting advisors and farmers in some cases, and that the project results are not always unambiguous (convincing), neither are they new or practically applicable.

Formas
In its objectives Formas has focused on a broad organic perspective, and on the interplay of livestock, land use and the environment, while at the same time demanding a high level of scientific quality, sector relevance and connections between theory and practice. With regard to "Livestock", Formas stressed that they seek projects concerning "production systems for pigs and poultry". In addition, the Formas framework includes a number of topics related to "Livestock":
- economics – markets and consumption
- food quality and health
- animal welfare
- working environment
- alternative disease prevention
- sustainability

• optimisation of entire production systems
• locally produced feeds
• alternative feeds
• preservation methods
• supplying amino acids to organic livestock
• adaptation of breeding goals to organic farming
• interactions between different animal groups

Most of Formas' prioritised objectives are covered within the research conducted. It should be noted however that no projects have covered "Interactions between different types of animals", and that the topic "Animal welfare" appears to be poorly represented in the research conducted.

Pig production systems appear to be particularly well represented, as Formas had requested. Poultry is also well represented, but the focus is not on "production systems", but more on disease prevention and feeding.

According to our evaluation, Formas' projects in the "Livestock" category exhibited good or satisfactory conformity with the funding bodies' objectives. The relevance of the projects for farmers and advisors was also good or satisfactory in most cases, and the projects in this category also scored well in terms of dissemination. However, the general assessment was somewhat less favourable with respect to capacity building: the projects did not generate much new knowledge for practical application. It should be noted in this case that some of the organic research currently being conducted does concern themes which have not been researched and documented previously, and which is consequently necessary, even though the results can often be predictable.

SJV

SJV stresses the importance of addressing concrete, current issues in its research projects, and seeks results that can serve as the basis for providing advice and recommendations in the short term. SJV seeks holistic studies at the farm and community level, with a view to reducing environmental problems and promoting biological diversity. The topics that SJV prioritises in the area of organic livestock production are as follows:

• combined enterprises with several types of animals
• pork, housing and production systems
• increased protein supply and increased protein utilisation with the help of regionally produced feeds

• milk and beef , systems for exercising animals that are tied up
• milk and beef, vitamin supplies without synthetic vitamins
• milk and beef, grazing systems for parasite control
• impact of type of production on product flavour
• milk and beef, feed preservation and storage
• eggs, protein supplies for layers
• eggs, design of balanced production systems
• chickens for slaughter, design of balanced production systems
• mutton and lamb, vitamin supplies without synthetic vitamins
• mutton and lamb, production technology for parasite control

SJV's priorities cover livestock production broadly, but are also highly specific and adapted to the current situation in organic agriculture (good priorities). The projects thus cover the prioritised goals fairly well. However, there are no projects on "Combined enterprises with several types of animals", "Impact of type of production on product flavour" or "Eggs, design of balanced production systems". In these projects there has been a strong focus on protein supplies from home-grown feed for cattle and poultry, which we consider to be very positive.

Scores for SJV "Livestock"
SJV's projects score highly in terms of meeting objectives, relevance, dissemination, and capacity building for practical applications, and overall.

SLF
SLF emphasises the quality of the research, that it must benefit Swedish agriculture, that the projects must consider environmental and ethical considerations, and that the effects on product quality must also be considered. SLF's objectives are not particularly specific, and no funds are allocated specifically for ecology.

SLF has prioritised the following objectives in the "Livestock"category:
• dairy production
• poultry
• meat production
• economics growth & business
• horses
• food market research

SLF has supported projects that tend toward basic research and are not particularly ecology-oriented. The projects are narrow, goal-oriented efforts to obtaining knowledge about

specific topics, with no holistic approaches taken except in the project concerning systems for pigs kept outdoors.

Dairy production is well represented in the research, and there was also one cattle project and another concerning meat production. There were no projects that addressed objectives relating to horses, economics or food market research.

Scores for SLF's "Livestock" projects
SLF's projects in the "Livestock" category generally conform well to the funding bodies' objectives, although they are unsatisfactory on this point in certain cases. A similar tendency is evident with regard to the relevance of the projects for the target group. The projects received disparate scores in terms of dissemination, but overall they were weaker than the scores for meeting objectives and relevance. The same applies to scores for capacity building with respect to the needs of advisors, which were also somewhat unsatisfactory.

SLU EkoForsk
None of the "Livestock" projects were funded solely by SLU EkoForsk, but SLU jointly financed four projects. SLU EkoForsk's objective is to help to resolve bottleneck problems impeding the development of Swedish organic production. With respect to livestock, there is an emphasis on providing animals with opportunities for natural behaviour. No additional goals are defined beyond this.

Scores for SLU EkoForsk "Livestock" projects
SLU EkoForsk projects in the "Livestock" category received generally good and satisfactory scores for conformity with the funding bodies' objectives. The relevance for the target group was good in one case and satisfactory in three. The marks for disseminate vary between good, somewhat unsatisfactory and even weak. The scores for capacity building with regard to practical applications are similar. The overall assessment was satisfactory.

Themes in the "Livestock" category addressed in the projects:
Cattle
Twelve projects under the main heading of "Cattle" were completed, representing 48% of the total funding appropriated for "Livestock" projects. The cattle projects conform well to the funding bodies' objectives; the focus in most of the projects was on the interactive effects of livestock, soil use and the environment, i.e. holistic aspects.

Pigs
Four projects representing 37% of the total funding appropriated for "Livestock" were carried out under the main theme "Pigs". One project was very large. The pig projects conform well to the funding bodies' objectives.

Poultry
Five projects representing 14% of the total funding allocated to "Livestock" were conducted under the main theme "Poultry". The poultry projects conform reasonably to the funding bodies' objectives, and are relevant, but they are not impressive in terms of capacity building. There are several ways in which the projects could have been planned to achieve better results in relation to the amount of money invested.

Sheep
Only one small project was conducted under the main theme "Sheep" accounting for 1% of the total funding granted in the area of "Livestock". This is noteworthy, as conditions in Sweden are favourable for the organic production of sheep on a commercial scale.

Horticulture

Horticultural research is being conducted in a number of different areas. The reported projects indicate that issues relating to plant nutrients, plant protection and cultivation techniques enjoy high priority.

These projects conform well with the funding bodies' objectives in many respects. Most of the projects are also fully relevant to the horticultural industry. The scores for the "Horticulture" projects are presented in Table 18.

The Panel notes that some projects lasted only one year or are of a one-off nature. In most cases it would be preferable for the projects to be longer term.

If the projects are categorised by cost, few horticultural projects number among the most costly initiatives. It is therefore clear that projects in the "Horticulture" sector are generally not as expensive as those in many other areas. The total cost of agricultural research can be viewed from an overall perspective, after which the costs are divided among the various sectors. If we then view the level of financial investment as a form of prioritisation, it is readily apparent that horticulture is a low-priority area.

Table 18. Scores for R&D projects in the "Horticulture" category.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	2	2	15	3.7	0.7
Relevance	0	1	2	16	3.8	0.5
Dissemination	4	4	5	6	2.7	1.2
Capacity building	1	1	11	6	3.2	0.8
Total	**5**	**8**	**20**	**43**	**3.3**	**0.9**

More projects in which several researchers cooperate would have been desirable, as projects carried out on a cooperative basis have proven to be successful. It is also easier to disseminate the results if a larger number of people participate in that important task.

The dissemination of the research results represents a weak link. Many projects start with high ambitions and clear objectives, but are ultimately communicated poorly to advisors and farmers.

The fact that many projects were not reported and thus could not be included in this evaluation (Table 11) represents a major deficiency. The unreported projects contribute to an incomplete and somewhat skewed evaluation (Table 16). We must in some cases note that certain research areas are missing even though the funding bodies have in fact granted funds for such research.

Given the desire to increase public consumption of fruit, berries and vegetables, it is obvious that the horticultural section should be granted an elevated status within Swedish agricultural research. What should be prioritised now are ways of producing them in Sweden at a reasonable cost and with reasonable labour intensiveness using organic methods, while not neglecting continued research into the benefits offered by horticultural products from a public health standpoint.

Formas

The horticultural projects financed by Formas are largely relevant and conform well with the funding bodies' objectives. On the other hand, the scores awarded are somewhat lower for dissemination of the results to the target group and capacity building in terms of practical applications. Not all of the projects meet the set objectives.

None of the reported horticultural projects come under the heading "Food – quality and health" in the Formas framework. This could be a high-priority area. The description provided in the framework is also very brief for this particular subject area.

SJV

The Swedish Board of Agriculture prioritises horticultural research highly, and granted research funding to eight different projects during the period 2000–2004.

Among the individual projects, four come under the heading "Cultivation of individual crops/crop groups", two relate to "Cultivation systems" and the remaining two come under SJV's priority area "Plant nutrient management and soil fertility". These projects correlate well with the funding bodies' objectives, and most of the projects have very close links to practical organic farming. The knowledge derived from the projects is easy to disseminate to the target group, and the results are directly applicable in many cases.

SLF

None of the reported projects we were given to evaluate was a horticultural project funded by SLF, even though horticulture was cited as one of SLF's 15 priority research areas.

SLU EkoForsk

SLU EkoForsk funded four horticultural projects and jointly financed another together with Formas. The projects were firmly grounded in practical organic horticulture, and the dissemination of the results was good. The results were well distributed via their website, which is informative and easy to read.

Systems and landscapes

The scores for the projects assigned to the "Systems & Landscapes" group are presented in Table 19.

Table 19. Scores for R&D projects in the "Systems & Landscapes" category.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	3	7	6	3.2	0.7
Relevance	1	3	7	5	3.0	0.9
Dissemination	6	3	3	3	2.2	1.2
Capacity building	2	4	5	5	2.8	1.0
Total	**9**	**13**	**22**	**19**	**2.8**	**1.0**

Formas

One post-doctoral position, one research school and one doctoral position were financed directly by Formas. This is fully consistent with Formas' framework programme, according to which research schools or thematic research groups are among the programmes given highest priority when awarding grants.

In Formas' framework programme, the following specialist fields are related to the heading "Systems and Landscapes":

- cultivation system ecology
- production systems for livestock, particularly pigs and poultry, and interactive effects of different types of animals
- technical/biological systems for organic agriculture and horticulture
- multifunctional agricultural systems

Formas financed ten projects relating to "Systems and Landscapes" and jointly financed an 11th project together with SLU EkoForsk (Table 11).

The research projects financed by Formas conform to the funding body's framework to varying degrees, but the conformity is largely satisfactory or good. The exceptions are two projects started prior to 2001 that do not fit within the stated framework.

Most of the projects in this group are large, receiving between MSEK 1 and 6 in funding. A number of them are innovative and diverse, and have generated new and important knowledge. On the other hand the scores for the relevance of this knowledge for the evaluation group's target group – farmers and advisors – do vary, albeit mostly between "satisfactory" and "somewhat unsatisfactory".

These scores must, however, be considered to be low in view of the heavy investments made in these projects. Knowledge of ecological interactions is one of the cornerstones of organic agriculture, and the programme included a number of large and comprehensive projects in which the ecology was studied, along with the environmental impact of organic agriculture. The problem in terms of relevance for our target group is that there is no focus on the organisms and contexts that are relevant to agriculture. A number of the projects focus more on biology than on actual agriculture. The new knowledge

generated by a number of these projects consists of basic data to help put organic agriculture in its ecological context.

The dissemination of the results to our target group, farmers and advisors, received generally low or somewhat unsatisfactory scores. Dissemination was limited even in those cases where the projects were relevant for the target group or the results would have been valuable to the advisory services.

The results from several of the research projects do have some relevance for the advisory services, but most of the projects, regardless of size, received low or somewhat unsatisfactory scores in terms of what they had to offer advisors. Some of the projects, particularly the few that were grounded in practical agriculture, did provide new knowledge that is directly applicable. The knowledge from many of the projects will be important in the long term. There were also a number of quite narrow projects that received major financing but had little relevance in terms of agricultural consulting.

The project with the highest scores in all respects, including in terms of result distribution, was one financed jointly with SLU EkoForsk. This cooperative arrangement put the project on a firmer commercial footing than a purely theoretical approach would have done.

SJV

SJV had three projects in the "Systems and Landscapes" group, including one major project funded entirely by the Swedish Board of Agriculture and a smaller project jointly financed with SLU EkoForsk.

The categories for both these projects are consistent with the SJV framework programme, some of the keywords for which included the composition and dynamics of cultivation systems, adaptation to ecological cycles and reduced negative environmental impact.

Because both projects were designed in consultation with practitioners, they are highly relevant for the target group. They are also innovative and topical, and have generated a great deal of concrete and directly applicable knowledge for the target group.

The programme has produced important knowledge that merits significantly greater distribution.

No report was submitted for the third project, even though it received a total of MSEK 1.25 in funding from SJV.

SLF

SLF has three projects in this group. None of them falls directly under the headings specified by SLF in its framework. SLF has no "Systems and Landscapes" category in its research programme.

Two of the projects scored satisfactorily for target group relevance. A number of the problem to which the projects provided answers are government-related, and necessary to the target group for that reason. The projects provided a lot of new basic knowledge of a more general nature, which will be needed to document organic agriculture for consumers, among other uses. All the programmes addressed government- and consumer-related issues.

The dissemination of the results was satisfactory for two of the projects, and good for the third, thanks to the fact that outside experts had been engaged and new techniques used to distribute the results. All the projects generated a good deal of new and usable information for the advisory services.

SLU EkoForsk

Within the "Systems and Landscapes" category, SLU EkoForsk funded one project on its own, cooperated with Formas on another and worked with SJV on a third.

SLU EkoForsk's concise framework programme states that EkoForsk will grant funding for organic research projects that are intended to remove factors limiting commercial applications, maintain high scientific quality, and are preferably conducted in the form of field research. This broad framework can accommodate many different types of projects. Two of the three projects conform well or fairly well with the funding body's framework. It should be noted that one of the projects was highly concrete and could perhaps better have been funded more directly on a commercial basis.

All three projects received satisfactory or good scores for their relevance for farmers and advisors, as the researchers cooperated systematically with representatives from the target group throughout the entire durations of the projects.

The dissemination of results was exceptional in one case, while more effort could have been expended in the other project. The target group is relatively small, and it should be possible to reach large portions of it with well-targeted communication.

SLU appears to enjoy good communication with its target group, and has succeeded in producing very valuable knowledge with relatively small investments.

One of the most innovative projects, which also produced the knowledge most relevant for our target group, was the one jointly financed by SLU EkoForsk and SJV. This project was both scientifically innovative and firmly grounded in reality.

Results broken down by funding body

Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas)

Formas has a research programme for organic production within which MSEK 23 were allocated annually for research on organic agricultural and horticultural production during the 2001–2003 programme period. The funding granted within the research programme breaks down as follows:

- research schools or thematic research projects: MSEK 10–12
- individual research projects: MSEK 6–8
- joint research programmes (jointly with other funding bodies): MSEK 4–6

Formas' research support goes toward targeted basic research and needs-based research. The research must be of high scientific quality and relevant to progress toward a sustainable society within Formas' areas of responsibility, i.e. the environment, land-based industries and spatial planning. Research grants are given to applicants at universities, colleges and institutions in Sweden. Swedish government agencies with research projects and their own research staff may also be eligible for funding.

In assessing the applications, both scientific quality and sector and social relevance are taken into account. According to the assessment criteria, the problems addressed must be relevant to the research areas specified in the call, and preference is given in principle to research of broad general value over research of limited general relevance. The degree of originality, new ideas, bold hypotheses and interdisciplinary approaches in the applications are weighed positively. The project description includes information about the scientific methods, working plan and cost plan. There is also a plan for dissemination, i.e. both scientific distribution and the distribution of popular science information.

Forty projects funded solely by Formas were evaluated for the research programmes' relevance and utility for farmers and advisors (Table 20). Seven of the projects were jointly

financed with one of the other funding bodies included in the evaluation. The reports requested for evaluation purposes were not sent in for an additional 16 projects.

Table 20. Scores for R&D projects funded by Formas.

	1. Weak	2. Unsatis-factory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	2	10	18	10	2.9	0.8
Relevance	5	9	17	8	2.7	0.9
Dissemination	18	11	6	3	1.8	1.0
Capacity building	6	19	9	4	2.3	0.9
Total	**31**	**49**	**50**	**25**	**2.5**	**1.0**

The agreement between the projects and Formas' objectives in the programme area is overwhelmingly good or satisfactory. The Panel finds the bulk of the projects to be good or satisfactory in terms of their relevance to organic agriculture as well. Nine projects received somewhat unsatisfactory marks and five weak marks for relevance to organic agriculture. The projects that were started during the earlier programme period are also included in the group considered to have weak relevance.

The contrary situation applies regarding dissemination. Dissemination of results was weak or somewhat unsatisfactory for most of the projects, although a small proportion received good or satisfactory marks in terms of distributing results to advisors and farmers. This is attributable in part to the fact that, according to their programme, Formas favours targeted basic research, which often yields results that are not immediately applicable in a production context. The programme also included one pilot study and several doctoral projects. Dissemination could not be evaluated for several of the projects as reports about the distribution of results to the target group were lacking.

The Panel's assessment of capacity building for consultants that was generated by the projects was somewhat more favourable than for dissemination. Most of the projects were considered to be somewhat unsatisfactory, while a few received satisfactory marks. Roughly one-fifth of the projects were considered to have provided advisors with useful, new and relevant information, while slightly fewer were graded as weak.

Have Formas' aims been relevant in terms of developing organic production?
Yes. The Formas framework programme is very comprehensive and at a relatively abstract level. Ecological awareness is very high, and is consistently incorporated into Formas' objectives. On the other hand, the funded projects do not fully live up to Formas' ecologically ambitious objectives.
Formas has the resources to finance the large, comprehensive projects needed to put organic agriculture into context. Some investments have been made in such projects, but the projects completed up until now have in many cases been insufficiently focused on the problems specific to organic agriculture.

Has Formas' work led to new knowledge of significance to the development of organic production?
The results of the research projects have sometimes failed to meet expectations. Even though the objectives have been ambitious, the research has relatively seldom led to anything new that is of importance to practical agriculture or the advisory services.The level of abstraction inherent in the project headings has often corresponded weakly with the level of the results attained. Research projects conducted under controlled conditions yield reliable solutions to specific problems, but it can be difficult to apply those results under practical conditions. We consider the fact that the bulk of the research was conducted on a large scale to be advantageous. The use of a large-scale approach should however entail a firmer grasp of and clearer focus on organic agriculture if the results are to accord with the ecological objectives.

Has the research increased opportunities for advisors to provide answers on current issues in organic production?
The question of whether the Formas funded projects have increased the capacity of advisors to provide answers to current production issues depends to a large measure on the final reporting, and the concrete guidance it includes. Because a large proportion of the projects have not yet submitted final reports, such an assessment cannot be made. Many of the projects deal with fundamental issues where the primary goal is not to generate directly applicable knowledge.

Have the results been made known to various interest groups in a satisfactory way?
In the overall assessment, the dissemination of results to our target group of farmers and advisors scored "somewhat unsatisfactory" and even "low". The distribution results for this

category were particularly unsatisfactory in view of the size of the investment.

Swedish Board of Agriculture (SJV)

The scores awarded by the Evaluation Panel to 28 SJV projects (excluding jointly financed projects) are presented in Table 21. The table shows that there is largely satisfactory or good agreement between the projects and SJV's objectives in the programme area.

The Panel also found that the projects scored satisfactory or even good in terms of their relevance to organic agriculture. Only one project failed to live up to the objectives and relevance standards (the same project in both instances), because it was originally launched under another programme area, and has thus been evaluated on the wrong premises.

Table 21. Scores for R&D projects funded by SJV.

	1. Weak	2. Unsatis-factory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	1	7	20	3.7	0.5
Relevance	0	1	6	21	3.7	0.5
Dissemination	5	5	10	8	2.7	1.1
Capacity builing	1	6	14	7	3.0	0.8
Total	**6**	**13**	**37**	**56**	**3.3**	**0.9**

Eighteen projects scored "satisfactory" or "good" for the dissemination of their results, while ten projects scored of "somewhat unsatisfactory" or "weak". The reasons for somewhat unsatisfactory or weak scores can differ from project to project, but typically the distribution was not focused on the target group (farmers and advisors) in presentations and articles; this lack of focus included the absence of articles written in Swedish for Swedish scientific journals.

Twenty projects received satisfactory or good scores for capacity building and new information to advisors, while five projects scored "somewhat unsatisfactory" and only one project had a score of "weak".

Has SJV had aims that were relevant to the development of organic production?
Yes. The programme area comprises both questions focused on key production or quality-limiting problems, and issues having more to do with the production system as a whole.

Have the research investments led to new knowledge that is important to the development of organic production?
Yes. More or less all SJV projects are relevant or highly relevant to the development of organic production. There are, however, a few examples where very significant problems have not been the focus of the research, while priority has been given to researching relevant, but less serious problem sets. There are thus important parts of the program area that have not been covered sufficiently.

Has the research input enabled the advisory services to provide more answers on current issues?
Yes. These projects scored well for capacity building with respect to advisory services for organic farmers. However, a few projects were more concerned with basic research, with the result that they cannot be expected to have practical applications in the short term, as was requested in the research call.

Have the results been disseminated to various interest groups (e.g. advisor and farmer) in a satisfactory manner?
No. According to the survey responses, roughly one-third of the SJV projects have not been disseminated satisfactorily to the target group of advisors and farmers. It is important to improve this aspect.

Swedish Farmers' Foundation for Agricultural Research (SLF)

SLF grants funding for research in 15 subject areas, including bioenergy, economics, market issues, fodder production, horticulture, meat production, plant nutrition and plant protection, plant improvement, potato cultivation, soils and crops, poultry production and sugar beet production.

Table 22 covers the projects for which SLF was the principal funding body and for which reports were available, a total of 13 projects.

Table 22. Scores for R&D projects funded by SLF.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	5	4	4	2.9	0.9
Relevance	0	1	8	4	3.2	0.6
Dissemination	5	4	2	2	2.1	1.1
Capacity building	1	4	6	2	2.7	0.9
Total	**6**	**14**	**20**	**12**	**2.7**	**1.0**

Has SLF had aims that were relevant to the development of organic production?
SLF made no separate calls concerning organic agriculture projects, nor was organic agriculture mentioned in their description/framework programme. In two of the three main areas one of the objectives was that production should be "sustainable". This description could thus include organic production, but does not call for such a production system specifically. Without a separate programme for organic agriculture, the research investments made in this area can easily become relatively non-systematic and the result an arbitrary choice of topics for research.

Table 20 indicates that the projects largely conform to the objectives SLF has set for its research. The Evaluation Panel did not consider any of the projects to be weak in terms of their conformity to SLF's objections.

The "Soils" projects conform to SLF's plant protection and nutrient metabolism objectives. Three of the projects concern plant protection in connection with the cultivation of barley/cereals, which was one of the three main areas mentioned specifically. Another deals with nutrient supply to meadows/grassland, which is one of the key factors in milk production, another of the three main areas. Holistic aspects with regard to, for example, sustainable production are lacking.

The "Crops" projects concerned plant protection, weeds and horticulture. Only one pest (aphids) was addressed, and we are uncertain as to whether an assessment of which pests pose the biggest problems was made before funds were granted. More holistic aspects in terms of work involving crop rotation and cultivation methods are missing here again, in addition to e.g. precision agriculture and quality, which are identified as important by SLF.

The "Livestock" projects include several in the area of milk production, while one concerns poultry and another pigs. These projects thus all fall within the scope of the three main areas identified in the SLF research programme. Mostly specific themes are addressed, and there is no particular focus on organic agriculture, so there is a lack of more holistic approach here as well, including in the areas of economics and the market. Some of the work in the area of milk production is, to a small extent, such that its results could be applied practically within 3–6 years, as SLF emphasises.

Three projects come within our "Systems and Landscapes" category. None of them falls directly under any of the themes cited by SLF. The projects have, in hindsight, proven to have generated useful and necessary knowledge for practitioners, including knowledge they require in their dealings with government agencies. SLF should consider expanding the sphere of its research to include issues that fall into this category, as such knowledge is going to become increasingly important.

There were no projects in our "Horticulture" category. Two of the projects in the "Crops" category do however deal with horticulture. SLF cites horticulture as one of its 15 research areas, and the group believes that SLF should invest to a greater extent in horticultural projects within organic agriculture. There are still many unresolved issues in this field, and Swedish production is unable to meet the demand for organically produced fruits and vegetables.

Has the research led to new knowledge important to the development of organic agriculture?
Among its criteria for assessing project applications in terms of relevance, SLF takes into account the potential of the project to bring about concrete and tangible improvements for primary producers. Emphasising this aspect in determining allocation of funding may have provided a good basis for ensuring that addressing problems relevant to organic farmers was important in the projects evaluated here.

The Panel considers all the projects (except one) to have satisfactory or good relevance for farmers. However, some of the projects are more concerned with of basic research, and their results have not led to practical applications or concrete advice. As a result, it may take some time before their results become useful to farmers. The same applies to project results relating to the development of new and innovative methods from which practitioners can benefit in the projects evaluated here.

Has the research increased opportunities for advisors to provide answers on current issues in organic production?
The Panel found seven of the projects to be satisfactory or good in terms of such capacity building. Only one of the projects was found to be weak in this regard. However, it must be made clear that successful capacity building also involves the dissemination of information, and when this is lacking, even if the research results are relevant, their value is limited.

Have the results been made known to different interest groups in a satisfactory manner?
A plan for dissemination of results is one of the criteria applied by SLF in assessing project applications. This includes checkpoints for predetermined schedules and type of publication.

However, only six of the 13 projects received satisfactory or good scores for result dissemination to practitioners. A number of projects failed to sufficiently utilise existing opportunities for dissemination. We see a need for more written information targeting advisors and farmers/growers in particular. Verbal information reaches only a few people, while written information affords better opportunities for distribution both spatially and over time.

SLU EkoForsk

Our assignment included the evaluation of research projects funded by SLU EkoForsk during the period 2002–2004 (Table 23).

SLU
Swedish University of Agricultural Sciences

Table 23. Scores for R&D projects funded by SLU EkoForsk.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	0	1	12	3.9	0.3
Relevance	0	0	1	12	3.9	0.3
Dissemination	0	2	3	8	3.6	0.8
Capacity building	0	1	8	4	3.2	0.6
Total	**0**	**3**	**13**	**34**	**3.6**	**0.6**

The objective for this period was to solve problems that were imposing limits on increasing the area of land under organic cultivation in Sweden. To determine which factors actually constitute such bottlenecks, input was obtained from county agricultural societies, county councils and the Swedish University of Agricultural Sciences (SLU).

The projects granted funding by SLU EkoForsk must be of high scientific quality. There are also expectations that the research will result in advisory materials and articles.

The official call for organic research from SLU EkoForsk is very concise. It gives wide scope for different types of applications, and also gives the funding body a very free hand in prioritising the projects for which funds are granted.

In reviewing the projects, a four-point scale was used for evaluation purposes. SLU EkoForsk projects received good scores and they break down according to the various evaluation criteria as follows:

Has SLU EkoForsk's research had objectives relevant to the development of organic production?
Has the research led to new knowledge important to the development of organic production?

Almost all the research projects solely funded by SLU EkoForsk received the highest scores in terms of both conformity with the funding body's set objectives and commercial relevance as a whole. None of the projects scored in the lower half of the grading scale.

Our perception is that SLU EkoForsk is very familiar with the practical problems, and invests its resources the right way to attempt to find solutions to them. It is also beneficial to involve a number of different organisations with broad expertise, such as county agricultural societies and county councils, in order to identify the real problem areas.

Has the research increased opportunities for advisors to provide answers on current issues in organic production?
The Panel's task was to assess the extent to which the projects contribute to innovation in organic production in Sweden. Does the project provide new knowledge to farmers and advisors?

As noted above, it is our perception that SLU EkoForsk is thoroughly familiar with the relevant "bottlenecks". This has resulted in the research funding being used for the "right" kinds of research. The projects fall into the top two assessment categories with regard to capacity building.

The conciseness of the research call that allows SLU EkoForsk great freedom in how it grants funding has made it difficult for the evaluation Panel to identify any subject areas that are being neglected. We presume that the good communication with the advisory services will continue, so that EkoForsk will continue to have a sound understanding of the problems with which practitioners are grappling, and which impede increased organic production in Sweden.

Have the results been made known to various interest groups in a satisfactory manner?
The scores for this assessment criterion varied broadly. None of the projects fell into the lowest assessment category, "low", but they did range from "somewhat unsatisfactory" through "satisfactory" to the highest category "good". There is clearly room for improvement in this area. It is also evident that the results from projects in which several researchers are involved usually enjoy better dissemination than results from projects that are dependent on a single researcher. It is thus advantageous in terms of result distribution when a number of researchers are involved in addressing what are, in our view, very important problems.

The Panel has also noted that SLU EkoForsk uses its website in exemplary fashion, and the group is pleased to point to that website as an excellent illustration of how to communicate research results in a way that is clear and readily comprehensible.

Jointly financed projects

The scores for the jointly financed projects are presented in Table 24.

Table 24. Scores for jointly financed R&D projects.

	1. Weak	2. Unsatisfactory	3. Satisfactory	4. Good	Average	Standard deviation
Objectives	0	0	2	8	3.8	0.4
Relevance	0	0	2	8	3.8	0.4
Dissemination	0	2	3	5	3.3	0.8
Capacity building	0	1	2	7	3.6	0.7
Total	**0**	**3**	**9**	**28**	**3.6**	**0.6**

As the table shows, the jointly financed projects that were evaluated generally received high scores in terms of their conformity to the funding bodies' objectives, target group relevance, target group distribution and capacity building. Eight of the ten projects received good scores for both conformity with the funding bodies' objectives and relevance for the target group. The scores were somewhat lower with regard to dissemination of the results, which may be due in part to the fact that the evaluation was based on materials which were incomplete at the time the assessments were made. Seven out of ten projects also scored well in terms of producing new

knowledge to meet the needs of consultants. As a general assessment of the jointly financed projects, it may be noted that they were generally well thought out, and that the division of labour was optimised in many cases with respect to the specific competencies and resources of the actors involved. It should, however, be noted that the number of jointly financed projects was relatively low, rendering our assessments somewhat uncertain. The assessments can in any event be viewed as clearly indicative of a general tendency. Cooperation gives research projects breadth in terms of both acceptance and support and the approaches taken, and provides the required resources.

Discussion and proposed actions

In this chapter we will propose changes that could be made to improve relevance and utility for practitioners. We have considered, among other things, the current state of user involvement in the projects.

The degree of user involvement in conducting the projects varied among the different subject categories. Advisors were involved in only one "Soils" project, while practitioners were involved roughly half of the "Crops" projects, albeit not always in the planning stages. Practitioners were involved in many of the "Horticulture" projects, while in the "Livestock" projects contact with advisors was generally maintained throughout. The "Systems and Landscapes" category included projects where advisors both provided the initiative for the research and were involved in its realisation, as well as projects where the users' roles were peripheral from start to finish. Both approaches are clearly reflected in the relevance of the research for the users.

Research programmes and the application process

The amount of land under organic cultivation has increased markedly in recent years, but the production of organic foods has not kept pace, despite a large potential customer base. This provides sound justification for the view that the funding bodies should preferably have separate programmes for organic agricultural research, and should earmark funds for such research.

The group recommends that funds which have been earmarked for organic agriculture research not be used for basic research, but rather for projects that will have practical relevance within a five-year time frame. This includes both research and development projects.

The funding bodies should better define relevant subject areas in the field of organic agriculture and involving practitioners

early on in the process. The various funding bodies should coordinate their programmes and communicate with each other to discuss, among other things, the division of labour to be used. They must agree on what is important, and proceed from that basis.

To generate knowledge which is directly applicable, researchers must move away from the universities and communicate with advisors and farmers. Because organic production is concerned to a large extent with holistic systems, it is also necessary for people who have knowledge of the relevant context to be involved in designing the research programmes. It would therefore be beneficial for those who are assessing potential projects to have a background in organic agriculture, so that they have an understanding of the problems to be studied.

To make the research more relevant to users, the evaluation groups recommends that the funding bodies strive to involve the target group earlier on, both in planning the research and to serve as reference groups in connection with the execution of the project. A working model for the research calls could for example comprise a multi-step model, based on a priority list of agriculture-related problems formulated in close cooperation with the users. Such a model could also serve as a step on the way toward creating tools for addressing interdisciplinary problems, tools that funding bodies and institutions currently lack.

The dissemination of research results to advisors and researchers varied greatly, but was far too often inadequate. The evaluation Panel recommends that the distribution of results be improved by:

- requesting the inclusion, in each project application, of a plan for distributing results to purchasers, and for following up the result distribution in the final report.
- publishing articles in publications that reach farmers, such as *Ekologiskt Lantbruk* and *Lantmannen*. Agreements concerning such distribution could be entered into with the publishers of these publications.
- including the publication of results in popular science journals as another qualifying factor.
- using the funding bodies' websites better to distribute information, following SLU EkoForsk's excellent example.
- offering incentives for writers to publish, particularly in Swedish.
- encouraging cooperation between funding bodies and

researchers; jointly financed projects achieve better result distribution than projects involving just one funding body.

The Panel recommends maintaining the current level of advisory services in Sweden in order to bridge the information gap between the research and its users. Bridging this gap is not up to the researchers, but rather to those involved in the coordinated advisory work, who must have sufficient resources for that purpose.

APPENDIX 1

Research calls by SJFR and Formas

SJFR CALL 1996

Organic Agricultural and Horticultural Production – Research Programme 1996–1998

In Bill 1996/97:5, the Government proposes that the Forestry and Agriculture Research Council SJFR should carry out a unified research programme in order to support development within organic agriculture and horticulture. The proposal refers to the investigation of the present state of knowledge, ongoing research and the need for further research in organic agricultural and horticultural production on which SJFR has previously submitted a report (SJFR Report, 1996). It is proposed that the programme should amount to a total of MSEK 46.5. This money is to be available over the period 1996–1998.

This description of the programme has been drawn up by SJFR. Views have been obtained from Organic Farmers, Swedish Board of Agriculture, Cooperative Union and Wholesale Society (KF), Federation of Swedish Farmers (LRF), Swedish Society for the Preservation of Nature, Swedish Environment Protection Agency and National Federation of Horticultural Enterprises (TRF). Consultations have taken place with Swedish Farmers' Foundation for Agricultural Research.

What is meant by organic production?

The long term aim of organic production is to create a system that is sustainable from both the national and global perspectives. The objective is a production that is based on a self sustaining, sustainable ecological system, with humans integrated as a reinforcing factor. Production is permeated by a holistic approach to crop farming, animal husbandry and horticultural production.

It is an integral part of the objective that the production systems should be based on optimum utilisation of solar energy and an effective circulation of nutrients. Local and renewable resources should be used as far as possible, and substances foreign to nature, such as artificial fertilisers and chemical pesticides, should be avoided. The aim is that the long term

production capacity of ecosystems should be preserved and strengthened, and the diversity of nature and the landscape should be protected and developed. Within organic agriculture, emphasis is given to preventive measures to promote the health of domestic animals, and to the provision of facilities for these to carry out their natural behaviour.

The aim of organic agriculture is that the producer should be given a reasonable income and a good working environment, and that consumers should at the same time be offered food of high quality at reasonable prices. In addition to food, bio-based raw materials for industrial processing and also energy raw materials should be developed. The quality of products is seen as the result of quality along the whole chain of production, and comprises both the environmental friendliness of the products, their effect on human health, and ethical aspects.

Rules for what is today regarded as organic production have been laid down within the EU, and on the national level by KRAV. Organic agriculture is however a form of production under development which will change as knowledge and production methods are developed. In this respect, research has the responsibility to provide the knowledge base that is needed to open new ways and to find new solutions.

The need for research on organic production

Creation of a knowledge base and development of capability are important for supporting the increase in organic production that is demanded by consumers. In a future sustainable society, agriculture will have a key role, and increasing demands will be placed on economic management of resources, preservation of nature and ethical considerations. These functions must be satisfied simultaneously with the maintenance of good productivity.

In order to satisfy these demands, targeted long term research is needed on how the production systems are to be developed. Research in this area can also produce knowledge of long term sustainable strategies for economic management of natural resources that are valuable in a global perspective.

The need for system solutions in organic production requires interdisciplinary inputs, where researchers from different disciplines cooperate in applying different approaches to investigate the issues. In many cases, the complex issues involved demand system

science approaches. The integration of animal husbandry and crop farming that is of key importance for the circulation of nutrients in organic agriculture requires research which ranges over process studies of the entire circulation of nutrients, the formulation of crop rotations/feed regimes and the way animals benefit from specific feed crops. There is also a need for cooperation between natural science and social science disciplines, for instance with regard to the adaptation of organic products and production methods to the consumers' wishes.

The objective of the programme

The aim of the programme is to reinforce the development of capability and knowledge which will promote long term development of organic agricultural and horticultural production in Sweden. Investment in research posts and researcher training will stimulate the development of qualified research groups of interdisciplinary profile. The programme also wants to provide facilities for researchers in the area to develop increased international contacts and to stimulate greater cooperation among areas of science/research groups in Sweden.

The objective is that fundamental studies, system studies and applied perspectives should complement one another in a productive manner, and that research results should contribute answers and solutions to important issues in organic production. It is expected that the knowledge generated will also to a great extent benefit the whole of agriculture and horticulture. Cooperation and dialogue between research and interested parties, in the entire chain from producer to consumer, are important and must be promoted.

The organisation of the programme presupposes that the research area concerned will continue to be supported after the end of the programme period.

Criteria for research support

Research within the programme must be socially relevant, problem oriented and of long term significance. Identification of problems must be based on a holistic approach and consideration of ethical aspects. Research should aim to produce system solutions which make it possible for the functions of ecosystems to be reinforced in both the short and the long term, with due regard to economic management of natural resources in both a global and local perspective.

The following will be considered in allocating funds to activities in the programme:

- scientific competence
- quality and relevance of research plans, including the choice of issues and methodology
- participation in other interdisciplinary cooperation, networks, joint experiments in the field, international cooperation, etc
- degree of urgency of the issue with respect to the development of organic production.

The focus of the programme

Sustainability is a key concept which must be defined and given a concrete form for agricultural and horticultural production. Methods for the analysis and evaluation of different functions and procedures in agriculture, on farm and regional level, should be drawn up. One essential task is to develop new productivity and effectiveness indices, in which the use of natural resources and environmental impact are coupled to traditional economic parameters.

A key issue for organic production is *economic management of energy and resources*, something that demands research inputs on both system and intrascientific level. The endeavour to become independent of fossil energy necessitates increased use of renewable energy sources and improved efficiency in the supply and use of energy. Development of knowledge and methods is needed concerning energy economic and environmentally friendly technologies in several areas (weed control, feed conservation and greenhouse cultivation, etc).

One of the objectives in organic agriculture is that the production systems should be developed based on *functioning ecocyclic systems* with minimised losses and environmental loads. System studies concerning the flows of resources and substances are essential tools for the correct selection among optional courses of action. Criteria and models are needed for well functioning ecocyclic systems, both within the local production concerned and for overall production, the food industry and society in different parts of Sweden.

The business economic and macroeconomic conditions for increased organic production should be further elucidated. Analyses of decision processes at different levels (primary producers, distribution firms, political decision makers), and the evaluation of the possible economic and political control instruments, are other urgent tasks. Greater adaptation to the long term

objectives for energy economy and sustainability may have structural consequences that should be analysed, such as effects on profitability, the provision of essential supplies for the rural population, and the quality of life.

The demand by consumers for well balanced foods of high quality, produced in sustainable systems, is one of the factors that influence the chances of development of organic production. The relationship between the costs of products and the willingness of the consumers to pay these should be quantified in research. The relationship between the quality of products and the health of consumers should be studied, as well as the health consequences of e.g. greater recirculation of organic waste for humans and domestic animals.

The relationship between land and town can be developed on several levels. Models in which the consumer directly contributes to the support of agriculture and the functions of the ecosystem should be tested. Research should also elucidate how production and processing systems can be optimised in view of varying local and regional conditions.

Knowledge should also be developed on how functioning *systems for dialogue* among researchers, society, producers and consumers can be organised. The objective is that it should be possible to make use of the experience of producers in research, and to effectively transmit the results of research to producers and society in a dynamic process. One component in this might be the development of a new field research/experiment methodology where problem analysis and evaluation of results take place in cooperation with the farmer.

The necessary *integration of crop farming and animal husbandry* in organic production, as well as a likely future shortage of food, imply that animal husbandry must change so that it is mainly based on the processing of greencrop fodder and crop materials that are unsuitable for human consumption. Greater knowledge is therefore needed concerning new feedingstuffs and conservation methods, factors that govern the chances of using greencrop fodder, the value of different pastures, etc. The synergistic effects in a multifacetted crop farming and animal husbandry system may be different in different parts of the country, and must be tested in research. The possibilities of better utilising the unique characteristics of different animals in agriculture should also be evaluated.

One essential cornerstone of organic production is that good production must be associated with consideration of *the wellbeing of animals and their opportunities for natural behaviour*. Greater knowledge of the needs and conditions of each animal species is essential for the formulation of principles for housing and feeding, modified feed regimes and a good environment. The interaction between humans and animals is also a significant factor in animal husbandry, and it should be further elucidated.

One urgent task is to develop and evaluate different *preventive measures against diseases and attacks by parasites.* A well functioning preventive health care also demands the development of a breeding programme to produce robust animals with a good immune system and good climatic adaptation. Research should also chart and elucidate ethical values and conflicts of interest in organic animal husbandry, and should propose solutions to these issues.

Rational management of plant nutrients is a key issue in organic agriculture and horticulture, in both the long and the short term. Greater knowledge of the processes that are important is systems with limited supplies of plant nutrients is essential in achieving optimum utilisation and minimum loss of nutrients. Research concerning the turnover of organic materials and the long term effects of different cropping measures on the fertility of the soil is of essential importance.

Another research area of key importance concerns the creation of a *cultivation system for the control of weeds, diseases and insect pests.* Strategies should be developed to strengthen the stability of cultivation systems through utilisation of biodiversity and natural mechanisms for self regulation. There are great demands concerning knowledge of the biology of pathogenic organisms and utilisation of the configuration of the landscape and wild flora and fauna in control systems. In both agriculture and horticulture, development of healthy seeds and a well adapted variety mixture, with good ability to compete with weeds and resistance to diseases and insect pests, is work of great importance.

In horticulture there is a special need to broaden the variety of organic products. Achievement of this requires the development of a well functioning cultivation system for several plant

varieties, which necessitates extensive research inputs concerning all stages of production, including product development.

In organic agriculture and horticulture, the vision is that agriculture, parallel with the production of food, should to an increasing extent provide society with raw material for energy production and for industry. An analysis of the changes and conflicts which such a development entails is necessary to identify the research issues that should be prioritised in an extended perspective.

Arrangement and organisation

The programme comprises the following activities:

- research posts
- research projects
- support for international cooperation (visiting researchers, post-doc stipends, journeys, etc)
- support for joint Nordic research training
- support for synthesising work
- coordinatory tasks
- research information

The programme wants to give special encouragement to applications in which researchers from several disciplines participate, preferably in the form of major cooperative projects.

A group comprising representatives of research, business and society is responsible for appraising applications. The group has the responsibility for cooperation between the programme and other players/activities, and must also ensure that a functioning dialogue is created among researchers and producers, consumers, society, etc, and that the results of research are disseminated effectively to those who use the research results.

Funds are available for programme seminars and the exchange of information, and stimulation of popular scientific publishing. Special programme coordinators will have the duty of coordinating activities within the programme, for instance with regard to the utilisation of field tests, contacts with groups of research result users, and information inputs.

Researchers who are granted funds within the programme have to attend the programme seminars that are arranged, and have to help ensure that the results of research, in addition to the

usual scientific publication, are quickly made available to business and society.

The Council stipulates that existing experimental stations, field tests etc should be utilised as long as possible, and that research should be conducted in cooperation with other ongoing activities in this area. Postgraduate researchers should as far as possible complement their training by participation in Nordic research courses in organic agriculture and other relevant programme activities.

Consultation and coordination

Consultation concerning programme activities will be undertaken with Swedish Farmers' Foundation for Agricultural Research. In making decisions concerning project support, account will be taken of similar activity supported by other funding agencies, e.g. Foundation for Strategic Environmental Research MISTRA. Programme activity will also be coordinated with the experimental and development work of the Board of Agriculture and Swedish University of Agricultural Sciences SLU.

RESEARCH CALL BY FORMAS 2001

Research Programme concerning Organic Production

The ambition of the Government to achieve the environmental quality objectives, that 20% of the agricultural area should be changed to organic production by the year 2005 and that organic animal production should increase, has had the result that for the period 2001–2003 MSEK 35 annually has been allocated for research concerning organic production. In the Budget Bill for 2001 it was proposed that MSEK 23 of these funds should be allocated to Formas for the implementation of a research programme for organic agricultural and horticultural production. (See Budget Bill 2000/01:1, head of expenditure 23, p. 90).

Research programme

Against the above background, Formas has decided on research programmes of the following preliminary magnitudes within the framework of the MSEK 23 allocation:

- postdoctoral research centres or thematic research: MSEK 10–12
- individual research projects: MSEK 6–8

• joint research programmes: MSEK 4–6 (research programmes jointly financed by the Foundation for Agricultural and Environmental Research, Swedish Farmers' Foundation for Agricultural Research and the horticultural industry.

Definitive allocations will be made depending on the quality of the applications.

Most of the programme concentrates on postdoctoral research centres, thematic research or combinations of these. The reason for this is that in this area there is a great need for both new researchers and for the provision of facilities for researchers, who have recently been awarded their doctorates, to develop issues of interest. In funding postgraduate and research assistant posts, Formas considers it is reasonable that universities should stand for a certain amount of co-funding and should assume the financial responsibility for a 4th year after the end of the organic programme.

Since Formas has the mandate of the Government to take the initiative in coordinating funding with the other affected research funding institutions in e.g. the food chain, the research programmes/projects may also contain elements which are to be financed by another national research funding institution.

For all three categories, the requirement is for the highest scientific quality and sectorial relevance, and that the coupling between theory and practice should be evident. As regards the content of the programme, the research community is invited to submit proposals. The following may however, without being ranked in order of priority, be seen as examples of what Formas considers are areas where further study is important:
• Economy – market – consumption
• Ecology of cultivation systems
• Production systems with domestic animals, especially pigs and poultry (eggs and meat), and the interaction among different animals
• Technical-biological systems for organic agriculture and horticulture
• Multifunctional agricultural systems
• Turnover of plant nutrients
• Food – quality – health

The programme does not contain projects which focus on energy or waste management. A more detailed description of the above areas is given in the following.

Economy – market – consumption

A relatively comprehensive change to organic production systems involves a pronounced change in the fundamental functions of the food chain. An analysis of the effectiveness of the different policy instruments in relation to sustainable development is necessary. The economic conditions may change in all stages as a result of new and/or modified technologies and changes in consumption patterns. In the light of this, a number of important problem areas can be identified.

Logistics and techniques in the processing industry and retail trade are affected due to a higher degree of product differentiation. An analysis of how the cost structure is changed in the existing large scale systems in comparison with the "small scale" installations that are not so capital intensive is of key interest. It should also be of interest to analyse how the cost situation is affected by IT based information systems. Increased knowledge of the economic value of "organic" or closely associated types of product attributes, factors that affect the accessibility of the products on the market, and the causes of new trends in consumption patterns are examples of important research areas where the results of a comprehensive method development within the economic discipline can be applied.

Increased product differentiation in combination with a changed degree of concentration in the processing industry and retail trade can also mean that any gains in social welfare that may be made on the market are reduced or unequally distributed among producers and consumers. Empirical and theoretical studies of the economic effects of new techniques in a long term adaptation to "new" product attributes, and the influence of industrial forms of organisation in the food chain, therefore appear to be particularly important areas for future research inputs.

The ecology of cultivation systems

One key issue in facilitating a large scale change to organic production is whether – and if so, how – problems caused by weeds, plant pathogens and insect pests can be combated without recourse to chemical control agents. If loss in production caused by weeds and insect pests is to be limited to acceptable

levels, it is necessary that we should understand which factors it is that determine the dynamics of weed species and insect pests in the landscape, and also what individual farmers can do to limit the effects of weeds and pests both on their own farms and on a larger regional scale. In order to achieve this long term objective, it is necessary to have a general knowledge of the dynamics of weeds and pests in the agricultural landscape, and an understanding of how different farming measures (inclusive of plant nutrient regimes) and the configuration of the landscape affect the interaction among crops, weeds, pests and their natural predators. It is such insights that will increase the ability of individual farmers both to reduce the populations of weeds and pests during the stages that are critical for the growth of crops, and to enhance the effectiveness of the natural predators in the farming system.

Other important issues concern the effects which a large scale change to organic farming has on other ecological processes in the agricultural landscape. What is the effect on the distribution of different species and on biodiversity? What evolutionary changes – e.g. in the form of changes in life cycles, altered feeding preferences, or changed habitat demands – are likely to occur as a response to new farming methods and/or new population densities and species compositions in the affected plant and animal communities? How does an increased proportion of organic farms in a region affect the population dynamics of insect pests on the surrounding conventional farms, and vice versa?

To prioritise a rapid acquisition of knowledge in the area ecology of farming systems, it could be appropriate to bring together a number of researchers and postgraduate students from a number of key natural scientific areas (e.g. plant pathology, large scale population dynamics, weed biology, production biology) in order to find new opportunities for the solution of problems important for organic production on farming system and landscape levels.

Production systems with domestic animals, particularly pigs and poultry (eggs and meat), and the interaction among different animals

Properly thought out animal management can improve the productivity, rational environment and resources management and stability of agriculture. Animals can in addition contribute with unique products or services and can also add other values

to the farm and the landscape. The term production system comprises the combined farming and animal management system.

The new forms of production that have been developed in organic animal management give rise to new questions and problem complexes. Examples of these are the need for changed breeding targets, alternative ways of preventing or controlling infectious diseases, feed regimes that must be composed according to criteria that are to some extent different from those used in conventional animal management, different kinds of animals, integration of animal and crop farming, or problems in the form of altered disease spectra as a consequence of new environmental conditions for the animals.

What production levels are suitable in view of ethical and biological limits? There is a great need to develop completely new systems for animal management, based on the requirements of organic farming for a holistic approach, sustainability and good animal care. This makes it important to develop, through research, knowledge and techniques that promote development of organic animal management in harmony with an integrated crop farming and to make this into a competitive option in both the short and long term. Research should focus on optimising the entire production system. Long term research is required concerning system solutions, with cooperation between animals and crop farming. The new regulations for organic animal management which the EU has adopted (augmentation of EU Regulation 2092/91) also demand some problem solving of a more short term character, e.g. cost effective conversion to new kinds of animals. The system perspective for individual animal species, or the interaction between several animal species, should be broad and comprise aspects such as feed, environment, housing, species-specific behaviour, infectious disease control, ethics and animal care, as well as preventive healthcare and alternative methods of treatment. Important issues concerning the animals are:

- *Feeding*. Special development of locally produced fodder of the proper amino acid composition, alternative fodder and methods for conservation, optimisation of feed regimes based on domestic or locally produced raw materials that satisfy the nutritional requirements of animals, and development of fodder analyses suited to organic agriculture.
- *Environment*. Development of special housing systems that permit a good animal environment, design of outdoor areas

including development of feeding and watering techniques.
• *Management.* Especially with regard to outdoor activities, herd composition, mother-offspring relations and how these can be respected and also positively utilised in production, transport and slaughter.
• *Breeding aspects.*
• *Human-animal-crop farming-environment interaction, inclusive of work environment issues.*

The scope of organic pig and poultry production is today relatively limited. Formas would therefore welcome applications that specifically concern the development of production for these animal species.

The attention of groups of researchers which plan to submit proposals in this area is called to the fact that it may be appropriate to study the investments made at the Swedish Institute of Veterinary Medicine with a view to possible joint planning. (See Budget Bill 2000/01:1, head of expenditure 23, pp. 30–31.)

Technical-biological systems for organic agriculture and horticulture

Organic agriculture and horticulture focus on sustainable systems and sustainable development, comprising ecological, economic and social sustainability. Research so far has to a large extent focused on the biological/ecological subsystems. Broadly speaking, all measures taken by humans in production – and thus the effect they exercise on the ecological and biological subsystems – are however taken with the help of technical systems and technical equipment. It is therefore important that biological/ecological research should be conducted in cooperation with technical research. The lack of knowledge concerning the relationship between technology on the one hand and biology/ecology on the other, and the way the technical systems must be developed to support and accelerate the development of organic agriculture and horticulture, must be remedied.

Investment should focus on development of knowledge concerning the relationships and dynamics in the interface between technology and biology/ecology and should address subareas such as the relationship between technicology/ technical systems and
• soil biology and soil physics
• process control during the vegetation period, e.g. the supply of plant nutrients and control and regulation of disease and weeds

• quality control
• housing, feeding and management systems in animal production
• guidance and control of storage processes for products - work and company organisation, cooperation and social structures
• evaluation methods for the assessment of the environmental and sustainability effects of different technical solutions

Multifunctional agricultural systems

A multifunctional agriculture and horticulture produces, apart from food, fuel and fibres, also ecosystem services and recreational, aesthetic and cultural environmental values. In combination with sources of income such as tourism and small scale processing on farm level, this creates the basis for employment in the countryside. The objective is agriculture and horticulture that is more sustainable ecologically, economically and socially and will benefit the people who live in the countryside, as well as society as a whole.

Landscape elements and ecosystem functions that are necessary for the generation of ecosystem services in the cultivated landscape must be identified and integrated into the agricultural system. This may result in significant recreational and aesthetic effects at both farm and landscape level through enrichment of the landscape with new landscape elements.

Agriculture and forestry with an intentional production of ecosystem services and/or recreational, aesthetic and cultural environmental values require new systems for financial remuneration of the cultivators. The way taxation rules, allocation policies etc affect the willingness and abilities of the cultivators to produce in a sustainable/multifunctional manner should therefore be studied and policy instruments should be formulated.

Sustainability in agriculture and horticulture can be studied in many different ways, and these can give different results depending on the choice of method. It is therefore essential to test a large number of methods, to be aware of the possibilities and limitations of these methods, and to find whether it is possible to integrate different methods to achieve a greater understanding of the effects of different measures on the entire agricultural system.

In developing sustainable agricultural systems, different interested parties – ecological, economical and social – are involved in the process. The way the conflicts of objectives that may

arise are managed is an important area that must be elucidated. The development of multifunctional agricultural systems demands cooperation in research within ecology, economy, rural development and landscape planning.

To sum up, research is needed mainly in the following areas:
• Ecosystem services in the cultivated landscape
– identification of ecosystem functions and landscape elements
– economic measures and policy instruments to promote ecosystem services
• Methods for the analysis and development of sustainable agricultural systems
• Methods for management of conflicts of objectives in designing sustainable agricultural systems
• Design of multifunctional agricultural systems of the future at different levels, from farm level to landscape level

Turnover of plant nutrients
In the agriculture and horticulture of today as a whole, there is a regional imbalance as regards the availability of plant nutrients. Some regions have a major nitrogen and phosphorus surplus while others have a lower one. The reason is that the relationship between fodder-animal-farmyard manure-crop farming/market gardening is disrupted.

In organic agriculture and horticulture, the endeavour is to integrate animal husbandry and crop farming, which has been successful on organic livestock farms. It is however more uncertain what development on the organic crop farm or market garden will be like. Will they be able to integrate their production with organic livestock farms or with society, so that the circulation of plant nutrients is resource efficient, and losses of plant nutrients are kept at an acceptable level?

In organic farming, grassland is important also on farms without animals. Important questions are how grassland/green manure crops are to be utilised to promote a good plant nutrient supply, and how the losses to the surrounding environment can be minimised. Production of biogas is an interesting option in this context which should be developed and its potential tested to a greater extent. Other fields of use for grassland products in society may also be of interest. In new systems where crop farming and animal husbandry cooperate, the management of farmyard manure is an important issue. How can we, in purely technical terms, develop management of farmyard manure so that it promotes a good work environment,

animal environment and animal health, and at the same time there is good management of plant nutrients and losses of plant nutrients to the surrounding environment are the minimum?

What type of farmyard manure management is optimal under different conditions? What is the significance of unbalanced distribution of farmyard manure during crop rotation with respect to economical management of plant nutrients and plant nutrient losses? How can production of bulk fodder of high nutrient content be reconciled with good management of plant nutrients in farmyard manure?

To sum up, research is needed mainly in the following areas in order to improve management of plant nutrients in organic agriculture and horticulture:
• Knowledge of how the farmer/market gardener can control turnover of organic matter.
• New techniques and better management systems for farmyard manure and other organic fertilisers.
• Greater knowledge of the significance also of nutrients other than nitrogen, phosphorus and potassium.
• Supply of plant nutrients in systems without animals. Biogas production. New fields of use for grassland products.
• System studies of the advantages and drawbacks of a large scale structural change towards the integration of crop farming and livestock farming.

Food – quality – health
The starting point for a sustainable diet is that the food must satisfy the primary nutritional needs, i.e. supply the physiological needs of the individual for growth and function, provide the conditions for good health and reduce the risk of diet-related diseases. The food must also be good and be produced in an ethically acceptable way, where consideration is given to the care of animals and nature and global solidarity. The quality of organic products is to be seen as a result of the quality of the entire chain from production to consumption.

To enhance knowledge and understanding of the relationship between growth site, cultivation measures, the plant's content of different substances, and the need of mammals for mineral substances, protective substances, substances that affect smell and flavour etc, is a challenge for agricultural research. Can we grow/produce food raw material with a "functional food" effect (food/fodder with higher health values than the products

normally available on the market) in a well developed organic agricultural system? How can different methods (including holistically-oriented methods and dietary studies) be used to study food quality and health effects? The following areas should be accorded priority:

• What qualities are specific to organic foods and how are these measured?
• The effect of organic agriculture on human health.
• The effect of growth site, variety/breed, production method and processing of product quality.

The attention of groups of researchers who plan to submit proposals in this area is called to the fact that it may be appropriate to study the investment made by the National Food Administration with a view to possible joint planning. (See Budget Bill 12000/01:1, head of expenditure 23, p. 65).

In prioritising applications, Formas will accord importance to the following in addition to the usual criteria concerning scientific quality, competence and sectorial relevance:

• international cooperation (particularly with Denmark, where similar research inputs are being planned at the same time, in regard to pigs, poultry, eggs, market gardens)
• coupling between theory and practice (possibly using experimental stations)
• interdisciplinary approach
• participatory research (cooperation practitioners – consultants – researchers, and/or experimental farms)
• scientific basis and an effective realistic organisation for the work.

Formas Call 2004

Call for applications for research funds in the fields of organic production, climate, marine environment and environmental toxicology (2004)

Formas has the task of promoting and supporting research in the fields of the environment, agricultural sciences and spatial planning. Research must, through developing and disseminating new knowledge, contribute to sustainable development of society. For such development to occur, it is essential that the health and wellbeing of humans and animals, biodiversity, the environment and the viability of nature, economy, ethics and social and cultural conditions are given due consideration. The research supported must be of high scientific quality and be relevant to the spheres of responsibility of Formas. Formas

finances both basic research and need-related research. The applications received are assessed by expert panels which are dominated by prominent active researchers. Special expert panels will be established for the assessment of applications in the fields set out below.

Available funds are generally sufficient only for funding a small proportion of the submitted project proposals. This means that only applications of very high class can be considered for funding. Success thus requires very good ideas and well prepared applications.

This call for applications refers to projects commencing on 1 July 2004. The projects may extend over one, two or three years. For research assistant posts, funds for four years can be applied for, but a grant is only given for the first two years, after which a new application can be submitted for the remaining period. The applicant must have been awarded a doctorate. Funds are allocated only to universities, technical universities or institutes in Sweden.

Applications in all the relevant scientific areas are welcome. Most of the projects normally financed by Formas have a natural science character. Formas therefore welcomes new project proposals also from areas of science other than the natural sciences. Within social sciences, examples of research that is urgently needed are the driving forces, obstacles and control instruments relating to development towards sustainability.

Projects must give consideration to gender perspectives where this is relevant. Grants from Formas may be used as Swedish co-funding in EU projects. On the application form, insert in the space "desired expert panel" the number of that of the four areas described below to which the application refers.

Organic production
In its budget bill in the autumn of 2003, the Government proposed to the Riksdag that, from the beginning of 2004, it should allocate MSEK 23 annually to Formas for research into organic production.

It is the ambition of the Government that the scope of organic production and livestock husbandry should increase. In order that this should take place in a way that is advantageous for humans, animals and the environment, research based knowledge is needed.

The term organic production primarily refers to cultivation without the use of chemical pesticides and synthetic fertilisers, and to livestock husbandry where the needs of livestock for natural behaviour are considered to the greatest possible extent. Research may comprise different parts of the entire food chain from primary production and processing to the markets for organic food, in both agriculture and horticulture. System analytical approaches are welcome. Comparisons with conventional forms of production are generally necessary.

Urgent fields of research are:

- livestock husbandry in interaction with integrated crop farming
- control of weeds, pathogens and insect pests without chemical pesticides
- turnover and losses of plant nutrients
- quality and health effects of foods
- biodiversity and ecosystem services in the landscape
- vulnerability/safety, resource and environment dependence of the cultivation system
- multifunctionality in agriculture
- driving forces, obstacles and control instruments in relation to the change-over
- institutional frameworks, organisational forms, markets

APPENDIX 2

Framework programme for SJV 2001

Reduced risk of pesticides
Environmental effects of plant nutrients
Organic farming
Biodiversity in the agricultural landscape

The Research and Development programme comprises the four programme areas mentioned above, concerning both agriculture and horticulture. Its purpose is to get a number of projects dealing with current, concrete and urgent issues started in each area. The plan is for the results of the programme areas to be used when advising or issuing recommendations on directly applicable measures in the near future.

As regards the programme areas, it is important that the entire cropping system's structure and dynamics are taken into account when individual projects are processed. The structure of the cropping system must as far as possible consider ecological facts and economic sustainability, so that these factors are reflected in concepts like recycling, reduced environmental load, conservation of resources, preservation of biodiversity, etc. These concepts are important in order to obtain long-term sustainability in our society, and therefore it is also vital that the agricultural sector integrates them into its production systems. Since competition is getting tougher, this approach is also relevant for the credibility of Swedish food in both the domestic and the EU market.

It will be necessary to coordinate both within and between programme areas in order to design and evaluate coherent strategies and systems, and to follow up on them with analyses of their effects on economy, energy, and the environment. This coordination is important in order for the efficient use of available means. There are some cross-cutting issues, like plant nutrient supply and the cropping system design. It is important for training and extension services that the projects and their results are made visible and given broad dissemination. Each project should include a plan for this.

Organic farming

Research and development in many areas is a prerequisite for the development of organic farming, if this form of production and livestock keeping in general is to achieve greater production reliability and higher quality. The proposals in this framework programme focus on relevant and urgent issues that can be implemented quickly. It is also important that the study of each issue is based on the resources at the location in question, and on the energy requirements. Negative effects like plant nutrient leaching must be reduced (see also subheading "environmental effects of plant nutrients"). Other central conditions for the development of organic farming are concern for health and welfare of consumers and producers, ethical norms, and rural development.

Below follow some examples of areas where research and development is particularly relevant.

Plant nutrient economy and soil fertility

- Development of methods that reduce plant nutrient leaching while preserving or enhancing the fertility of the soil.
- Plant availability of various organic fertilizers.

Cropping systems

- Crop rotations and nutrient supply that are sustainable in the long run, in cropping systems with or without livestock in various regions.
- Seed and varieties (strategies for seed production and variety testing).
- The effect of cropping measures on product quality.
- Disease problems in crop rotations with much leguminous plants.
- Weed control; in annual crops in sandy/loamy soils; perennials like dock, coltsfoot, and field thistle.
- Cultivation in organic soils.

Cultivation of individual crops / groups of crops

Plant nutrient supply is of main importance to all crops.

- *Oilseeds* – strategies against diseases and pests, weed control and measures against volunteer plants, sulphur supply.
- *Sugar beet* – establishing plants and competition from weeds, strategies against diseases and pests.
- *Potatoes* – cropping techniques against mildew, plant-available nitrogen in the spring.
- *Outdoor vegetables* – strategies against plant pests and weed, cleaning of seed.

• *Berry and fruit cultivation* – strategies against plant pests and weed.
• *Grassland* – regulation of botanic composition, new species in the grassland, potassium supply.
• *Cereals* – plant-available nitrogen in the spring.

Livestock production
• Production technique for keeping several animal together in combinated holdings.

Pig meat
• Housing and production systems.
• Increased protein supply and utilization using regionally produced feed.

Milk and beef
• System for exercising tethered animals.
• Vitamin supply without synthetic vitamins.
• Grazing systems for parasite control.
• The effect of the production form on the taste of the products.
• Increased protein supply and utilization using regionally produced feed.
• Conservation and storage of feed (for instance whole-crop silage).

Eggs
• Protein supply to laying hens.
• Design of balanced production systems (livestock numbers, group size, building design, size and use of the outdoor run, disease-preventing measures, environmental considerations).

Poultry for slaughter
• Introduction and testing of animal material
• Design of balanced production systems (livestock numbers, group size, building design, size and use of the outdoor run, disease-preventing measures, environmental considerations).

Sheep and lambs
• Vitamin supply without synthetic vitamins.
• Production technique for parasite control.

Formas, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, is a governmental research-funding agency. Formas encourages and supports scientifically significant research related to sustainable development.

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