

Evaluation report 2004

Evaluation of JTI's R&D Activities 2001-2004



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Preface

Formas shall promote outstanding research for sustainable development in the areas of environment, agricultural and forestry sciences and spatial planning. The research supported shall meet high demands for scientific quality and, where applicable, be relevant for the sectors of society concerned. The council shall also provide an impetus in initiating research that promotes economic growth in the sectors affected.

Agriculture is of importance to the Swedish economy, for the wellbeing of the Swedish population and for biodiversity. Agriculture today is not only a producer of food; it also supplies important services in the form of e.g. a visually attractive open landscape with open fields and pastures, recreational facilities, energy crops and other industrial raw materials.

Agriculture has the advantage that it produces renewable products. There are, however, central sustainability problems where research is needed. There is extensive use of non-renewable agrochemicals, of fossil fuels and commercial fertilizers. Chemical pesticides are extensively used, some of which leak into ground water and surface water. Nutrients are leaked from arable land and cause a significant proportion of the eutrophication of the aquatic environment.

Besides open calls for research applications, Formas also funds strategic research programmes in important areas. Under the spending budget of the Ministry of Agriculture, about 50 MSEK annually is allocated for research co-funded with the business sector. In the field of agriculture and agricultural research Formas has a 4-year agreement for the years 2001 – 2004 with the private farm owners and industry to finance equally 50 percent, or 5.1 MSEK, of the basic work carried out by the Swedish Institute of Agricultural and



Lisa Sennerby Forsse
Secretary General
Formas



Lars Larsson, Chairman
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Agricultural and
Environmental Engineering
(SJMF)

Environmental Engineering (JTI). Part of Formas responsibility is to initiate and organise scientific evaluations of the research financed by the council. At the end of the previous agreement period 2001 - 2004, Formas and the Agricultural Sector together decided to evaluate the work at the Institute. The purpose of the evaluation was to assess the scientific quality of the research carried out at JTI.

On behalf of Formas and the agricultural sector we are very grateful to the expert panel for their skilful and efficient work in evaluating a wide variety of activities in the institutes research and development work. Their findings and recommendations to both JTI and Formas and the agricultural sector is highly appreciated.

Lisa Sennerby Forsse
Secretary General
Formas

Lars Larsson
Chairman
The Foundation
for Agricultural and
Environmental
Engineering (SJMF)

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Summary

The aim of the evaluation of the Swedish Institute of Agricultural and Environmental Engineering (JTI) was to assess the scientific quality and the relevance of the R&D activities at JTI during the period 2001-2004.

The Panel of Experts has conducted an evaluation of publication performance (number and quality) and the scientific competence of the researchers. Presentations by research managers and discussions with them were used in the evaluation of project management competence, the capacity for co-operation, co-ordination and communication. The relevance of the R&D activities was examined, based on discussions with the research managers, the director of JTI, user response - in the form of impressions from the Federation of Swedish Farmers (LRF) - and the success rate of project proposals.

The Panel is favourably impressed by the quality of the research, both in terms of scientific quality and of relevance for agriculture, the environment and society. Management and scientists have a healthy vision of the R&D needs of the authorities (incl. society) and the farmers. Besides which, they have a clear view of how to effectively implement the results of the R&D work. A future challenge for JTI might be within the field of chemical substance application to crops.

Even though the number of international, peer-reviewed publications has increased, JTI's management has to set up a publication plan in order to increase this number further. The Panel recommends that position papers be produced to support project proposals. These could, typically consist of a critical review of the "state of the art", identification of JTI's role in furthering research in the field and the identification of collaboration partners with supplementary expertise. The selection of competence for achieving the identified goals of the research is more likely to attract basic research funding.

Evaluation Process

The principal objective was to evaluate JTI's performance during the period 2001-2004. The main emphasis was to assess:

- Scientific quality
- Relevance
- Dissemination of results
- Measures taken since the previous evaluation
- Overall conclusions

Panel of Experts

The Panel of Experts consisted of:

Aad A. Jongebreur, Director, Ir. Wageningen University & Research Centre, Wageningen, the Netherlands. Aad Jongebreur has a long career in the different aspects of Agricultural and Environmental Engineering. In the 80's he has been a member of the Board of Directors of the Agricultural Research Council (DLO; 1985-1989), responsible for the research for the branches in animal production. During 1980-1988 Aad Jongebreur was professor in Farm Buildings and Related Equipment at Wageningen University. In the period 1989-2001 he has served the Institute of Agricultural and Environmental Engineering as Director General. Within Wageningen University and Research Centre he is now director for Facilities and Services. Related Activities have been the presidency of the Royal Society for Agricultural Sciences (1991-1994) and chairman of the ENGAGE (EU institutes for Agricultural Engineering; 1992-1995). He has published articles on different topics, e.g.: Strategic Themes in Agricultural and Bioresource Engineering (2000), Future Dairying (1994), Future Trends in Livestock Housing and Design (2004), Emission of Volatile Gases (2003).



Aad A. Jongebreur,
Director, Ir.

Josse de Baerdemaeker, Professor Dr. Ir.

Josse De Baerdemaeker graduated as an agricultural engineer from the Katholieke Universiteit Leuven, Belgium. He obtained an M. Sc and Ph.D. in Agricultural Engineering from Michigan State University and did later post-doctoral research at Cornell University and University of California Davis. He is professor at the Katholieke Universiteit Leuven. His teaching and research areas focus on the interaction between physical processes and biological products for the design and control of novel technologies for the cultivation, harvest, handling and storage of crops. He is author or co-author of more than 150 journal publications. He is active in international organizations related to engineering and process control for biological systems and served in the period 1996-1998 as President of the European Society of Agricultural Engineers.



Josse de Baerdemaeker
Professor Dr. Ir.

Thomas Johansson, Agronomist

Vice President, Federation of Swedish Farmers,
(LRF) Stockholm, Sweden



Thomas Johansson
Agronomist

Procedures

The evaluation is based on written information provided by JTI, on interviews with a number of researchers, organisations, and farmers and heads of department, as well as on presentations made by research units at JTI and visits to some of the research facilities.

The Panel of Experts has held three meetings:

January 16, 2004 Introduction and information on JTI

March 17, 2004 Research meetings (see programme, appendix 1)

April 13-14, 2004 Conclusions etc

The Panel of Experts is grateful for all information and support received from JTI's Board and staff members and especially from Hans-Örjan Nohrstedt, Formas.



Scientific Quality

Publications from JTI

In the tables below, the publications are ordered according to what the Panel considers as JTI's main areas of activity. This grouping differs somewhat from the research programmes defined by JTI itself. According to the Panel, this better reflects the areas of expertise. Thus, we have the following categories:

- I. Crop Production Technology and Agricultural Machinery
- II. Ergonomics
- III. Animal Production Technology (including grain storage)
- IV. Nutrient Utilisation
- V. Waste Management and Treatment

Peer-reviewed international publications

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|------|------|------|------|------|------|------|
| Overall | 6 | 5 | 2 | 3 | 7 | 12 | 11 |
| Crop Production Technology and Agricultural Machinery | | | - | 1 | 1 | - | 2 |
| Ergonomics | | | 1 | - | 3 | 2 | - |
| Animal Production Technology | | | - | - | - | 1 | - |
| Nutrient Utilisation | | | - | 1 | 2 | 5 | 2 |
| Waste Management and Treatment | | | 1 | 1 | 1 | 4 | 7 |

Patent suggestions

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|------|------|------|------|------|------|------|
| Overall | | | | | 1 | | 3 |
| Crop Production Technology and Agricultural Machinery | | | | | - | | - |
| Ergonomics | | | | | - | | - |
| Animal Production Technology | | | | | 1 | | 2 |
| Nutrient Utilisation | | | | | - | | 1 |
| Waste Management and Treatment | | | | | - | | - |

International conference contributions and project reports

| | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|------|------|------|------|------|
| Overall | 24 | 15 | 23 | 22 | 23 |
| Crop Production Technology and Agricultural Machinery | 2 | 4 | 2 | 1 | 3 |
| Ergonomics | 6 | 3 | 3 | 8 | 3 |
| Animal Production Technology | 2 | 1 | 2 | - | 5 |
| Nutrient Utilisation | 4 | 5 | 10 | 6 | 7 |
| Waste Management and Treatment | 10 | 2 | 6 | 7 | 5 |

Appearances in national and local publications (in Swedish)

| | 2002 | 2003 |
|---|------|------|
| Overall | 148 | 167 |
| Crop Production Technology and Agricultural Machinery | 26 | 28 |
| Ergonomics | 29 | 42 |
| Animal Production Technology | 19 | 21 |
| Nutrient Utilisation | 17 | 42 |
| Waste Management and Treatment | 26 | 19 |
| Others | 31 | 15 |

Reports (in Swedish)

| | 2000 | 2001 | 2002 | 2003 |
|---|------|------|------|------|
| Overall | 22 | 25 | 20 | 16 |
| Crop Production Technology and Agricultural Machinery | 5 | 7 | 14 | 1 |
| Ergonomics | 1 | 1 | 2 | 1 |
| Animal Production Technology | 4 | 5 | 2 | 4 |
| Nutrient Utilisation | 10 | 7 | 7 | 5 |
| Waste Management and Treatment | 2 | 5 | 5 | 5 |

The number of international, peer-reviewed publications is increasing. This is a good evolution, in line with the recommendations of the previous evaluation. The Panel feels that the number of publications could still be greater, given the high level of research activity at JTI. The high level of participation in international conferences is one indication of this activity. A number of the contributions in these international conferences have been published in reviewed conference proceedings. However, efforts should be made to see that most of these conference contributions end up as peer-reviewed journal publications.

JTI's management stresses that, in a large number of research contracts with industrial companies, no time is allocated for the preparation of publications.

The number of publications in Swedish and the research reports in Swedish are considered to be of great importance for the implementation of the research results in practice. Indeed, the Panel was informed of the contribution the Institute's research makes toward formulation and implementation of the government's environmental policies and regulations. The Panel notes that the research around environmental issues (nutrient utilisation, waste management) is also the most productive in terms of basic research, which is reflected in the publication record. These research fields also address the needs and concerns of agriculture and rural society.

JTI's management should set indicators or publication goals for its staff. These could be, for example, two peer-reviewed international journal publications per postdoctoral researcher and per Senior Research Manager per year. In addition, there are the requirements of Swedish publications for each project funded by the Swedish Farmers' Foundation for Agricultural Research (SLF), for example, or other public authorities. It should be noted that the impact factor of the journals and a citation report on the publications is not yet available. This could be an additional tool for internal quality monitoring of the scientific work at JTI.

The international community, active in the area of agricultural and environmental engineering, considers JTI's research work to be of a high level and quality. Unfortunately, this is not reflected in the number of international, peer-reviewed publications.

The research programmes in environmental engineering (nutrient utilisation and biological waste treatment and management) and in ergonomics have been the most productive in terms of international publications and conference contributions. Animal production technology and grain storage are lagging behind in this respect. However, it is expected that a number of publications will arise from the successfully completed European research project on mycotoxins in grain storage. Similarly, the programmes on crop production technology and agricultural machinery have yet to publish the results of recently initiated projects.

Scientific Competence

According to the data obtained from management, the present number of staff at JTI is 49. Of these 34 are employed as researchers and 15 as support staff (meaning administrators, research technicians and workshop technicians). The distribution of



employment duration of the staff categories at JTI is shown below. It can be seen that over half of the research staff has been at JTI for less than 5 years. This means that there is sufficient influx of new researchers to promote a dynamic research environment while, at the same time, experienced laboratory and research technicians are still available. It should be noted, that there is an annual staff turnover of 11-22 % (average 15 %). This explains, in part, the large number of staff with an employment length of less than 5 years. In addition, a number of older staff members have retired in the last 5 years and were replaced with young researchers. No information is available regarding the turnover per staff category, the reasons for the departure or the new jobs taken by those who departed.

International conference contributions and project reports

| Employed in: | Duration of employment | Researchers | Supporting staff |
|--------------|------------------------|-------------|------------------|
| 1999-2003 | 0-5 years | 18 | 5 |
| 1989-1998 | 5-15 years | 9 | 4 |
| 1979-1988 | 15-25 years | 6 | 2 |
| <1978 | >25 years | 1 | 4 |
| Total | | 34 | 15 |

The educational background and qualifications of the researchers

| | 2000 | 2001 | 2002 | Forecast 2003 | Target 2004 | Target 2008 |
|---|------|------|------|------------------|----------------|----------------|
| Ph.D. graduates, no. | - | - | 9 | 8 | 10 | 12 |
| Agronomists, no. | - | - | 18 | 22 | >20 | >20 |
| Engineers, no. | - | - | 11 | 9 | >10 | >10 |
| Other background, no. | - | - | 14 | 15 | >15 | >15 |
| Research personnel, % of total staff | - | 75 | 75 | 77 | 83 | - |
| Admin/info/library personnel, % of total | - | 25 | 25 | 23 | 17 | - |

The proportion of 25 percent support staff appears to be reasonable, since this includes research and workshop technicians who are directly engaged with the research activities. This proportion is similar to what can be found in large research institutes in other countries.

The number of agronomists is high compared to the number of engineers. This ratio should be monitored carefully since it is important that JTI maintain a good balance between agricultural knowledge and engineering science.

The number of staff with a PhD is distributed evenly across the JTI's different research areas. It was noted that these PhD researchers are not necessarily the Heads of R & D who may, instead, have several years of research experience. Four of the PhD's introduce expertise from outside the established agricultural engineering field.

A number of researchers are currently involved in a PhD programme. This is considered a very expensive investment because of the considerable time required for course work and other learning duties. This time can hardly be accounted for in the projects. However, the Panel considers this to be an important way of assuring that 'state of the art' expertise and basic research are further developed.

Number of staff with PhD, 2003

| | |
|--|----|
| Overall (including director) | 10 |
| Crop Production & Agricultural Machinery and Storage | 2 |
| Ergonomics | 2 |
| Animal Production Technology | 1 |
| Nutrient Utilisation | 2 |
| Waste Management and Treatment | 2 |

The number of staff that submitted peer-reviewed publications or contributions to international conferences can also be used to measure the quality of the research staff. Precise numbers on this are not available, but a superficial count indicates that 25-30 percent of the research staff is active with such publication.



External Funding

JTI's base funding is 5.1 MSEK from Formas and 5.1 MSEK from the Foundation for Agricultural and Environmental Engineering (SJMF) - the industry base. This appears to be a good public-private co-operation in research. However, the two groups have different expectations from the research. Formas places more emphasis on basic research that addresses the needs and concerns of society. Industry, on the other hand, is more interested in research that, within short time frames, can be applied to industrial needs and problems. The way in which JTI responds to this duality in expectations is reflected in the publication record discussed above.

The core funding of 10.2 MSEK only represents one third of JTI's overall budget. Approximately 20 MSEK comes from external funding, obtained on a competitive basis from other government or industry foundations, or from bilateral contracts with agencies or companies. Although no exact numbers on the funding for each project were made available to the Panel, it appears that all the research areas are about equally active and successful in attracting of external projects.

A few remarks can be made with respect to the results of external competitive funding. Very limited project funding is evident from Formas. Here JTI comments that Formas is almost exclusively interested in basic research. On the other hand, JTI is quite successful in its project proposals to the Swedish Farmers' Foundation for Agricultural Research (SLF). This is an indication that JTI's projects are relevant for SLF, and thus for the agricultural community in Sweden. For example in 2002 and 2003 JTI received research grants from SLF of 3.3 and 6.1 MSEK respectively, which are quite substantial.

From the discussions, the Panel learned that, although JTI manages to submit relevant research ideas, the Institute often failed in the description of the research methods and in the

description of the international state of knowledge within the proposed research topic.

It is recommended, therefore, that the submission of a research project proposal should be based on an in-depth, critical review in the form of a position paper. The latter would also outline the expected developments in science and technology as well as within society.

In the discussions with SLF it became apparent that the farming community has great concerns about the use of chemical pesticides and about the chemical application technology. However, almost no research project proposals in this area are being submitted. This could be an opportunity for JTI, although JTI has no basic competence within this field. In order to capitalise on this opportunity, the Institute will need to examine the expertise necessary for such research (such as, pulsating fluid flow in pipes, control systems, disease recognition, crop and soil sensing, fluid droplet formation, air flow and drift modelling, etc), which expertise can be built up in-house and what can better be achieved through co-operation with other research institutes in Sweden or abroad.

Note that the basic study of pulsating fluid flow, in this context, is also of interest to research on milking equipment, for cleaning or for control of the vacuum levels in the lines.

During the past four years there has been active participation in six projects funded by the European Union. This is good and far above average given the size of JTI. One should also note that the current EU, Sixth Framework Research Programme is much more restrictive with respect to the range of topics considered for funding. There have been efforts made toward participation in Sixth Framework projects, but in the end, the topics were not considered eligible. Here again the Panel wants to stress that JTI's visibility in international publications is important for attracting invitations to participate in collaborative projects and for success in the resultant funding applications.

JTI has a number of projects with the Swedish Agency for Innovation Systems (VINNOVA). This is a clear indication that the Institute has the capacity and expertise to contribute to innovation.



JTI's Implementation of Previous Evaluations

Principal conclusions of the 1999 evaluation:

Strengthen the theoretical and analytical platform

Agricultural engineering research and development in Sweden is clearly oriented toward practical implementation of the widely appreciated research which fulfil a national need. The theoretical and analytical research platform behind these research results should be strengthened to be competitive in the international arena.

JTI has maintained the excellent co-operation with farming and industry, and there has been progress in identifying and developing expertise within specific areas of basic research. Good examples are in biological waste treatment and in nutrient cycle studies. The other areas of speciality have developed more slowly. A measure of the success of these areas would be the number projects approved by Formas.

The number of international, peer-reviewed publications has increased considerably since the last evaluation. The goal in the 1999 evaluation was set at 0.5 publications per man-year of the scientific staff. This would mean 17 peer-reviewed publications from JTI. The Expert Panel considers this goal to be too low and judges 45 - 50 articles per year to be more appropriate (see section Recognition outside JTI).

There is a strong and successful integration of existing hardware components while less attention is paid to the theoretical research principles behind novel processes or technology.

In some research areas, there is a lot of emphasis on demand driven R&D, leading to the mere incorporation of external technologies into designs. Less attention is then given to the transfer of methods which could further the understanding and development of engineering at the interface between biology and technology.

Renew and update research instruments and facilities

Agricultural engineering research in Sweden utilises research facilities that are adequate for the current activities. However, more attention should be given to the renewal and updating of research instruments and facilities in order to stay internationally competitive.

The fermentation and measurement facilities used in the collaborative work on biological waste treatment, with the microbiology groups at the Swedish University of Agricultural Sciences (SLU), are continually being upgraded.

A new installation, with measurement and logging equipment, was constructed for research on hygiene and cleaning in automatic milking systems.

The Panel was given a list of desirable instruments and equipment. Some items on this list are considered as normal upgrades or expansions of existing apparatus, which should be attainable within the normal operating budget.

Other items, like a thermal camera, a high-speed camera, dust measurement apparatus, rheology apparatus and RTK-GPS, require substantial investment. These should form a part of a clearly defined research and strategic expertise development programme.

Increase co-operation across scientific boundaries

Establish engineering competence to interact with biotechnology, crop production, molecular biology, and plant pathology for the co-development and evaluation of technology and new biomaterials.

Establish engineering foundations for assuring the quality and safety of food products.

A number of opportunities are emerging which could be developed further: The research on hygiene and the cleaning of automatic milking equipment clearly offers the opportunity for such collaborative work, as it also relates to food safety and food microbiology. JTI can be a leader in the research of precision agriculture, but to achieve full success, close co-operation will be needed with crop and soil science specialists. The needs for such co-operation should be made clear in the research activities and in the publications. The mycotoxin research has established international links with several biology research groups. The biological waste treatment and methane production



research are multidisciplinary. Similar observations apply for the outdoor pig project and the mobile slaughterhouse project.

The Panel would point out that JTI should take care to increase the engineering competence and research base in the above-mentioned projects. Otherwise, there is the risk that JTI could become a partner solely for its engineering capabilities and facilities while the other partners in the projects perform the actual basic research.

Competence Development at JTI

JTI has a number of application oriented projects. Some of these have received funding since JTI's staff had the foresight to recognise the relevance of these projects for agriculture and the environment and their potential for attracting funding. However, in a number of cases JTI does not possess its own base of expertise for these projects. These skills are brought into the projects through co-operation with other research groups.

Engineering design work is being carried out within the area of crop production technology. However, ongoing projects and activities do not represent a sufficient base for the future, unless a decision is made as to which areas of core competence will form the foundation of future activity. These could be for example, sensing principles, controls, vehicle guidance etc. In any case, the number of staff is limited and a strategic choice will have to be made.

Similar choices will be required within animal production technology. This ranges from the cleaning of milking equipment to mobile slaughterhouses, to outdoor pig farming, to grain storage. What is the real core competence here? Measurement and modelling could probably be the underlying fundamental competence.

JTI has specialists in some application areas, but to be competitive in the future there must be a development of the underlying expertise. The Institute's strategy must emphasise which areas of core competence it wants to develop itself in order to be an attractive and necessary research partner and not just an engineering partner. Examples of such core competence are:

- **Systems analysis, modelling and control**
Example applications: bioreactors and biological waste management, ammonia emissions, nutrient cycles
- **Measurement systems**
Example applications: ammonia emissions, soil sensors, bioreactor monitoring
- **Ergonomics**
Example applications: machine operators, animal husbandry

Although these areas may appear to be rather abstract, there are a vast number of projects in which such expertise could be applied and lead to greater success. These areas of speciality could also be used to enter into other application areas than those currently studied. Examples of this could be water quality or water use.

It is recognised that basic competence development should preferably be based on the core funding from Formas.



Mission, Strategy and Annual Plan 2004

JTI's Mission Statement:

"JTI researches, develops and provides information within the areas of agricultural and environmental technology and machinery. Our work provides industry and authorities with a sound basis for decision making, a stronger competitive edge and facilitates better management of natural resources" (Annual Plan for 2004).

In this mission statement, JTI might include co-operation within the broad area of agricultural sciences e.g. the area of life sciences and spatial planning in its connection with various sources of nuisance, such as noise from traffic, bad odours from different sources, water quality and waste treatment plants.

Collaboration

Despite the fact that JTI is relatively small, it is apparent that the Institute's scope of activity is very broad and that the fields of speciality follow the current developments within the fields of agricultural and environmental engineering. Seen in relation to the size of the Institute, the scope of international activity is also good.

A strategy of collaboration is the most logical way of complementing existing core competence. This would facilitate achieving "critical mass" within certain research areas or increase the level of excellence within others. Collaboration with the agricultural universities - SLU, Uppsala and SLU, Alnarp may open such possibilities.

The arguments for this are:

1. Co-operation with SLU would enable JTI to participate in basic research within several fields; fields in which JTI's capabilities, alone, are not quite at international level. An example of such a field is machine technology. In this way PhD work might also be better organised and yield greater benefits for JTI.

2. The integral approach or "holistic view" promoted by JTI (Analysis of the surrounding world and future prospects, JTI, 2004), would benefit from collaboration with scientists in the field of livestock engineering.

Recognition outside JTI

Publication of more articles, in peer-reviewed journals, is necessary for international recognition. One of the targets from "JTI's targets for the period 2004-2008" (shown in the table below) is to increase the number of publications by about 30 percent. The target, however, should be approximately 45-50 publications. The normal requirements (2 publications per scientist) should be mentioned in this document. The requirement of the funding organisations should be followed. In pursuing a greater number of scientific publications, JTI should be cautious not to reduce the number of other (popular) publications too much; these are valuable tools for conveying information and are effective for marketing.

| Activity | 2000 | 2001 | 2002 | Forecast | Target | Target |
|--|------|------|------|----------|--------|--------|
| | | | | 2003 | 2004 | 2008 |
| JTI reports, no. | 22 | 25 | 20 | 18 | 20 | 20 |
| Scientific publications (journals and conference proceedings), no. | 17 | 32 | 32 | - | 35 | 40 |
| International projects, % of JTI's total working time | - | - | - | 11 | 11 | 16 |
| Patent applications, no. | 0 | 1 | 0 | 3 | - | - |
| Equipment made for customers, no. | - | - | - | 6 | - | - |

Research Policy

From reading the documents (JTI's Annual Plan for 2004; JTI's targets for the period 2004-2008), it is clear that there is great ambition for further development. It is the clear aim to do both basic and applied research in the same areas. Good examples of this are seen in the areas of sustainable nutrient management, biological waste treatment and organic waste management. In these areas JTI maintains high, internationally recognised standards. This is a good basis for extending the field of application to industrial and communal waste handling. These developments are, largely the result of the fruitful co-operation with the Institution for Microbiology at SLU. The fields of application for the agricultural and environmental engineering are plant production technology, livestock production technology, biological waste treatment, and system studies, working environment and production economics. In the future,

it will not be possible to deliver good quality research results within such a large number of application fields and expertise fields (within sensor systems, vehicle and machinery, JTI International, animal environment and welfare, and milk production)

The fields mentioned above are a mix of application areas and disciplinary issues. A clearer definition of these fields should be made, following which; it would seem reasonable to implement the disciplinary issues within the relevant application fields. For example, milk production is a part of livestock production engineering; the topics of the animal environment and welfare could also be taken up in this area.

The Panel of Experts is convinced that JTI's work needs to become more focussed if it is to achieve international standards and recognition within each field. Achieving such a high level is a necessity, since both Formas and SLF emphasise this as a prerequisite for funding. It is important for JTI to focus on those fields in which a good strategic position has already been achieved. It is, however, the opinion of the Panel of Experts that this is not the case for all the fields mentioned above.

The Panel makes the following comments with regard to strategy.

We observe that the area of vehicle and machinery is, for an agricultural engineering institute, rather weak. There is a lack of expertise in the field of spraying technology, for example, where quite a number of practical problems have not yet been solved.

For new fields, e.g. bio- and nanotechnology, we recommend a thorough study of the literature and prospects for application in the form of position papers. Evaluate, using the 'state of the art' studies as a basis, if JTI should enter a new research field.

Combination of the area of systems analysis and production economics might be attractive. The development of models, dealing with important and relevant issues, is also of interest.

In terms of niches in the R&D market the field of 'working environment', where JTI has well-developed basic expertise, has good prospects. The recommendation is that this field can be extended on condition that there is continuous development of relevant expertise.

It is not only the new areas (bio-and nanotechnology, man-machine interaction) which should be of interest for JTI, but also the implementation of specific expertise within the more traditional fields e.g. machinery and milk production.

Owners Equity and Financing

JTI's ownership is shared by Formas and industry (including the farmers' organisation LRF - to a large extent connected to the farmers as end-users of products from industry). It should be noted that the Swedish Farmers' Foundation for Agricultural Research (SLF) is also very important to JTI for project funding. This combination of different owners and important target groups is unique and well worth maintaining. This is a challenge for the Institute, since it is necessary to combine basic, strategic research (including the development of new expertise and methods) and applied research in such a way that the "customers and owners" are satisfied with the results of the work carried out.

The Panel of Experts has the following comments:

Basic funding of 8.6 MSEK for JTI is, in the opinion of the Panel of Experts, a minimum for conducting satisfactory research work. This estimate takes into consideration the breadth of the working area and the questions related to governmental policy and the needs of the society. Part of this funding is necessary for maintaining the infrastructure and knowledge base.

The Panel of Experts is of the opinion that JTI plays an important role in the area of environmental policy and addressing the environmental concerns of society. This role includes the generation of knowledge, from a fair and internationally acknowledged position, as well as more practical applications, dealing with environmental concerns. How can policy be implemented in a manner that is satisfactory for authorities and for farmers? JTI is well placed to address this issue as it has carried out good quality research, relevant for the authorities and the farmers, within the areas of sustainable nutrient management, biological waste treatment, organic waste treatment, emission reduction of ammonia and global warming gases and the reduction of emissions from tractors. See further discussion under: "Scientific Quality".

JTI needs to progress, in terms of research quality, in the specialised fields e.g. machinery, crop production technology. This means improving the international position of the research through the publication of peer-reviewed articles and position papers based on the literature. Research and the publication of results are essentially integrated and cannot be separated. This is one of the prerequisites for future funding from both Formas and SLF. Examples in other countries indicate that it is possible to combine strategic, long-term research and applied and sometimes more short-term research.

JTI's strategic development must be the subject of regular follow-ups in order to ensure that the targets established are achieved. The development of targets with respect to performance indicators is also part of the process, e.g. the use of the "Customer Satisfaction Index". A basic and critical factor for successfully carrying out the strategy is the involvement of the scientists in processes like balancing the different targets of Innovation or Knowledge Generation, Markets or Account Management (Research Managers of JTI), Management of Resources and Financing. The Panel's recommendation is to set targets as measurable and achievable goals both for the Institute, the groups and the employees.

Looking at the financial targets for the future, it is normal in business to set a profit target. However, to remain in balance between income and expenditure this percentage should increase to 3 percent. Depreciation of equipment and instruments should be covered from project funding. Looking at the proportion of "overhead", 33 percent is relatively high but not extreme for an institute of this capacity. The target for 2004 indicates a relatively drastic reduction to 20 percent. The total turnover of approx. 3.3 M€ (30 MSEK) with a total of 50 workers is 66 k€ (600 000 SEK) per worker, or approximately 100 k€ (900 000 SEK) per scientist. This is somewhat lower than corresponding figures in the Netherlands. This implies that JTI's costs are quite moderate. Regarding the time spent on projects, it seems that the proposed reduction in time booked for the framework programme, would only result in 4 percent more time for projects and commissioned assignments. Comparison of the income from the framework programme and from the project funds indicates that there should be an even greater reduction in the time booked to the framework programme. Stricter management on this point is necessary in order to win time for writing good research proposals and for the development of expertise.

Relevance

In order to form a picture of the relevance of JTI's activities, the Panel of Experts has proceeded in the following way:

1. Read and studied the publications issued by JTI.
2. Talked to a large number of interested parties, who can be grouped into the following categories:
 - Farmers and machine-owners, i.e. considerable users of technology.
 - Companies, preferably ones that are members of the Swedish Foundation for Agricultural and Environmental Engineering Research (SJMF).
 - Municipalities.
 - Authorities and government offices.
3. Gone through national-level publications.
4. Talked to financial backers and decision-makers within research funds.
5. Furthermore, the Panel of Experts has drawn from its own experiences and networks.

Relevance is divided into different parts for the purposes of assessment. As a general comment, it can be said that what JTI publishes in the agricultural trade press, is read and evaluated with great interest. This means that relevance is high in those fields where results from research and experiments reach the practical farmer.

With regard to the machinery companies, which are members of SJMF - there does not appear to be great interest in utilising JTI's competence more than the basic financing allows. A somewhat higher interest is noted in the area of labour conditions, comfort and safety connected with the health of workers.

For authorities that have the task of implementing the national environmental objectives, particularly the Swedish Board of Agriculture (SJV) and the National Environmental Protection Agency (SNV), JTI has performed valuable services by formulating recommendations and suggestions based on the Institute's knowledge. This is especially true as regards manure treatment and application, gaseous emissions and waste disposal. SJV emphasises that certain fields of competence, which are important to the authorities, are only available within the Institute on a national level. This applies mainly to the field of manure treatment and the application of plant nutrients. With regard to research foundations, of which the dominant interested party is the Swedish Farmers' Foundation for Agricultural Research (SLF), the conclusion can be drawn that relevance in the projects is high. In the assessment of funding applications, SLF gives high priority to relevance.

Financing of projects at JTI by SLF amounted to 3.3 MSEK in 2002 and 6.1 MSEK in 2003. This amounts to 20 percent and 29 percent, respectively, of the funding that was applied for. Of the funds applied for from the Royal Swedish Academy of Agriculture and Forestry (KSLA), 25 percent and 31 percent were granted in 2002 and 2003, respectively; this is primarily financing for participation in conferences and similar activities. The total amount from KSLA was around 250 000 SEK.

With regard to society, several of the objectives for environmental quality set by the government apply to the agricultural sector. The social objectives, which otherwise refer to the sector, are above all that agriculture shall be socially, organically and economically sustainable. When assessing JTI's R&D activities in relation to these social objectives, projects dealing with labour conditions, physical and mental loads or safety in general, were identified as the most relevant.

There are many interpretations of what falls under 'organic sustainability'. The broad interpretation is that agriculture as a whole qualifies as 'organic'. Therefore, it can be said that much of the research relating to the environment at JTI is relevant, according to this interpretation. The definition of organic may also be limited to cultivation without the addition of non-organic plant nutrients or chemical pesticides. In this respect, the Panel observes that JTI has initiated an organised development of production methods based on research in combination with experiments. There is a need for this type of research and relevant knowledge; the cultivation method, in its present

form, is relatively new. It can also be mentioned that the Swedish government has set targets for the proportion of total production, which is to be by organic methods. In order to meet these targets, and to meet the demands of society, there is a need for research around the development of production methods. This research is, however, still at an early stage, which means that quality and benefit were not assessed by the panel.

Economically sustainable agriculture is promoted through the interaction of many different factors. Some of these are affected by the R&D activities at JTI, such as for example, general development of technology, as well as specific development projects that are funded, primarily by the research foundations. Yet, it is important for Swedish agriculture that the basic competence be available within the country, partly in order to be able to develop technology according to Swedish conditions, and partly in order to be a receiver and conveyor of international knowledge. JTI seems to fill the gaps by covering areas where other national institutes and universities do not seem to have sufficient competence. If this competence is not maintained, then there is a great risk that development in Swedish agriculture, with regard to both production technology and the quality of the environment, will be left behind.

With regard to society's objectives for environmental quality, we would like to emphasise the relevance of JTI's work within the field of waste disposal and the application of nutrients in agriculture.

Sensible management of the resources generated by society, through waste of different sorts in densely populated areas, and returning these to the eco-cycle is, in the highest degree, a relevant research task for a research institute that is partly financed by society. We note, with satisfaction, that JTI is internationally well in the forefront within this particular field. Results from JTI's R&D work within the fields of plant nutrients, fertiliser disposal and emissions from animal husbandry were also relevant and important in the Panel's evaluation of research that addresses the environmental quality objectives.

Agriculture needs support in finding and developing competitive production methods within adopted environmental objectives. Likewise, authorities need R&D and support from the specific knowledge and expertise available at JTI, in order to draw-up and implement regulations. In this respect JTI is

also well in the forefront, within the areas related to environmental issues, both nationally and internationally. This is also the research area where JTI has provided most benefit for society and for agriculture. The return of investment in these R&D activities has been good. A challenge for JTI might be the application of chemicals in crop production.

Other fields of research carried out at JTI, e.g. sensor technology, are of importance for competitiveness and the development of technology that is more resource economical. Work with milk quality and technology is relevant, not only for customers, but also for the general accumulation of knowledge within the food safety chain.

There is both need and scope for more collaborative research in addressing the environmental quality objectives. JTI's technical expertise could more effectively contribute to developments within the branch, through co-operation with, for example, the research programmes Food 21- Sustainable Food Production (MAT21), Management of Seminal Grasslands - Economics and Ecology (HagmarksMistra) etc.

JTI's provision of results and information to both advisors and active farmers has worked satisfactorily thus far. There is currently a partial restructuring of the information strategy underway, where some printed matter is to be replaced by web-based material. This should not negatively affect distribution of the results from JTI's R&D work.

It should be pointed out, that an important role of a research institute is to be an explanatory link between research and the provision of advice. Generally speaking, many institutes and university departments miss this link within the agricultural sector in Sweden. The Panel considers that JTI performs this specific task relatively well.

In the year to come, it is of great importance that both the Board and the staff at JTI make a relevant and wise assessment of what is to be given priority. The basis can be found in those fields where there is presently strong competence (see further "Scientific Quality"). Further, careful consideration must be given to whether this competence can be applied within fields, which are presently of interest for society and agriculture, or are likely to be so in the future.

Conclusions on Relevance

The relevance of the research and development carried out is generally high.

Relevance is generally greater within the fields with higher quality research.

Commissioned tasks or projects naturally have relevance for the customers.

According to society's objectives, the relevance of JTI's work is considered high.



Dissemination

Information and dissemination of results to Swedish agriculture and society in general is carried out through a number of different channels:

Web-site: Number of visitors per month unknown

Digital reports: Unknown number

"JTI Informs": approx. 2 000 copies per edition, of which 1 600 to subscribers

Press and other media: Appearances nationally, 148 in 2002 and 167 in 2003

Scientific publications: Discussed elsewhere in this report

Taking into account the resources JTI has at its disposal, the Institute is very comprehensive and effective in its efforts toward spreading information to the general public and the dissemination of results. Recently, though, the information department was reduced substantially from 3.5 to 1.5 employees.

Based on the information we have received, with regard to how work will be performed in the future, there appear to be good prospects for a continued acceptable level of dissemination of information.

In the agricultural press, where JTI has been well established for a long time, the Institute is often represented in the form of articles, interviews or abstracts. This is important from the point of view that interested farmers get an idea of what is available from the Institute.

In the table in section Publications from JTI, the number of published articles is shown for each of the main themes.

In those fields with high levels of activity, high quality research and good competence there is also a good record of dissemination of results and of implementation.

As mentioned in the section on relevance, certain activities at JTI, especially within the fields of livestock, manure and waste disposal, form a partial basis for the authorities' regulatory and advisory function. In this case, implementation and application of the R&D results is very rapid.

Information and transfer of results focus, quite naturally, on the agricultural sector, particularly within fields with technological applications. This focus serves the interests of the Institute well.

It is more difficult to assess the dissemination of information from JTI to the public sector and construction sector, within the fields of waste disposal etc. The conclusion can be drawn from the project lists that experts within the field indeed know of the JTI's R&D activities. However, a more public dissemination of JTI's results, within all its fields, would be desirable. Clearer information would also be desirable regarding the relationship between different research programmes and objectives set up by society, such as objectives for environmental quality and animal welfare.

Conclusions on Dissemination

Good dissemination of traditional agricultural information through both agricultural press and popular articles.

Relevant industry gets the information needed through known channels.

Methods for dissemination of information to other fields, e.g. environmental technology, are under development; the present situation is acceptable.

Conclusions

The conclusions of the evaluation team are drawn on the basis of discussions with LRF, the members of SJMF, municipalities, the board of JTI and the staff members and also the presentation of the research projects and results.

- 1 The relevance of the research projects carried out by JTI is generally high. In the research area of environmental engineering the relevance of the research projects is considered to be excellent, because of the needs of society for a better environment. The authorities - the Swedish Board of Agriculture (SJV) and the National Environmental Protection Board (SNV) - are satisfied with JTI's research work. The contributions made by JTI, to the implementation of regulations on a national basis, are recognised. JTI is generally in the forefront, nationally and internationally, in this research area. The evaluation team stresses the fact that basic and strategic research is successfully combined by JTI in the area of environmental engineering - and this is an example for all other core activities.
- 2 Relevance and quality of the research work at JTI are highly correlated. Research needs from JTI's industrial partners are rather low and not well defined.
- 3 The following areas of R&D are also relevant: production methods and engineering for organic and sustainable agriculture, the labour conditions with regard to the health of the workers and the application of electronic equipment in agriculture and precision agriculture.
- 4 The Panel is favourably impressed by the quality of the research at JTI in each of the main areas of activity.
- 5 Although the number of peer-reviewed articles is increasing, the publication rate is still below acceptable levels. As indicated by the publication record, the research areas of environmental issues and ergonomics are the most productive.

- The implementation of the recommendations from the previous evaluation has led to an improvement in the number of peer-reviewed articles, an excellent co-operation with farming and industry, the update of research instruments in fermentation research and equipment for research on hygiene and cleaning of milking systems. The co-operation across scientific borders must be further developed, following the good examples of mycotoxin research, methane production and nutrient utilisation. **6**
- The Panel commends JTI on the national dissemination of the research results, which is highly appreciated by the agricultural and the rural society. Industry is receiving the information it needs and the transfer of information to the target groups for environmental issues is acceptable. **7**
- In the Panel's opinion, a clearer definition of core specialities at JTI, e.g. systems analysis, modelling, measurement systems, ergonomics, must be made in order to make more explicit choices of which research areas to be active in. **8**
- JTI has been successful during the last 4 years in the participation in EU projects (within EU FP 5). **9**
- To maintain and implement international standards for research quality it is necessary that the current, basic funding of JTI be continued. This basic funding is, in relation to figures available from other institutes (not universities), rather moderate. **10**
- The overall management of JTI is sufficient to good in terms of research management, market and international orientation; taking into consideration the large number of R&D areas. **11**
- The Panel believes that JTI's principal strengths are: **12**
- Relevance of the research projects to the agricultural and rural society.
 - The combination of basic and application oriented research with regard to internationally recognised environmental issues.
 - Innovative attitude and good engagement of board and staff members with JTI's customer groups.
 - Good international orientation and position within the broad area of European research within agricultural and environmental engineering.
 - Good public image on the basis of reports on environmental issues.

- 13 The Panel believes weaknesses are:
- The clear definition of JTI's areas of competence.
 - The international visibility of JTI on the basis of peer-reviewed articles.
 - The formulation of research methods and the scientific 'state of the art' of knowledge in specific fields.
 - General acceptance, by the researchers, of international quality standards.
 - Relatively high turnover of scientific staff.



Recommendations

Peer-reviewed articles

The international position of JTI can be improved by an increase in the publication of peer-reviewed articles. This can be achieved with a publication plan for the Institute and for each scientific staff member. The contributions to international research work can be worked into articles. Writing peer-reviewed articles can help JTI to achieve greater success in research proposals.

Communication with stakeholders

Maintaining good communication, through the publication of reports in Swedish and the publications in the agricultural and general press, can keep the national visibility at its present, good level. The plans for publication on the web should be monitored.

Instruments and equipment

The Panel has received a list of instruments and equipment desirable for research work. While thermal and high-speed cameras, dust measurement equipment and RKT-GPS require substantial investment; the Panel recommends these as well as investment in an expertise development programme.

Basic engineering competence

The Panel of Experts has observed that the development of basic engineering competence must be enhanced through a soundly established plan, and should preferably be financed by core funding from Formas.

Research proposals

It is recommended, that the submission of research proposals should be based on in-depth, critical reviews in the form of position papers. In these papers, the expected developments in science and technology as well as in society (technology assessment) can be outlined.

Challenges

The Panel believes that several challenges in the agricultural and environmental engineering fields are worth working into the research programmes, e.g. the application of chemicals in agriculture, measurement of environmental parameters (dust, noise, global gases) and even some non-agriculturally related projects (in spatial planning). For JTI to be a potential leader within precision agriculture close co-operation with animal husbandry, crop and soil science specialists is necessary; the international conference can be a starting point for this. Pursuing new research areas such as biomaterials, bio- and nanotechnology requires close co-operation with specialists at universities and other research institutes.

Sustainable agriculture

JTI should be established and promoted as being a significant contributor to an ecologically based and sustainable agriculture. Staff members should be engaged in discussions around sustainable development in order to achieve a better understanding of sustainability in connection with the Institute's working areas.

Appendices

Appendix 1.

Programme for the SJMF/Formas evaluation of JTI

Wednesday March 17

17.30 - 18.15

Introduction (JTI Conference Room)

Lennart Nelson*

19.00

Dinner at the Restaurant Guldkanten in the newly reopened market hall in the centre of Uppsala

Thursday March 18

08.00 - 08.45

Synthesis Research (JTI Conference Room)

Christel Benfalk*, Andras Baky and Kristina Lindgren

09.00 - 09.50

Biological Waste Treatment (Centre of Microbiology)

Åke Nordberg*, Mikael Hansson and Johnny Ascue

10.10 - 11.10

Milkproduction (University Farm Kungsängen)

Christel Benfalk* and Mats Gustafsson

11.30 - 12.00

Storing of Grain and Mycotoxin (JTI Laboratory)

Nils Jonsson*

12.00 - 13.00

LUNCH

13.00 - 14.00

Agriculture and Environment (JTI Conference Room)

Lena Rodhe*, Göran Carlson and Gunnar Lundin

14.00 - 14.40

Working Environment (JTI Laboratory)

Anna Torén* and Qiuqing Geng

14.40 - 15.00

Coffee

15.00 - 16.00

Sensors and Site Specific Agriculture (JTI Conference Room)

Mikael Gilbertsson*, Anna Rydberg and Lars Thylén

16.00 - 16.20

JTI International (JTI Conference Room)

Christine Jakobsson* and Ola Palm

16.20 - 17.00

Summing up (JTI Conference Room)

Lennart Nelson*

(* = responsible)

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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