International Evaluation of Swedish Research Projects on the Environmental Impacts of Wood Fuel Harvesting

Report to the National Board for Industrial and Technical Development

NUTEK-R--95-43

NUTEK
Swedish National Board for Industrial and Technical Development

International Evaluation of Swedish Research Projects on the Environmental Impacts of Wood Fuel Harvesting

Report to the National Board for Industrial and Technical Development

Professor Mike Hornung, Professor Seppo Kellomäki and Professor Jørgen Bo Larsen

R 1995:43

National Board for Industrial and Technical Development
S-117 86 Stockholm, Sweden
Visiting adress: Liljeholmsvägen 32
Telephone: +46 8 681 91 00. Fax: +46 8 19 68 26
Telex: 10840 nutek s

PREFACE

This report is the result of the special evaluation group engaged by NUTEK to assess the ongoing research and at the same time provide a platform for the structuring of future work in the research programme of the environmental impacts of wood fuel harvesting.

The success of an evaluation is a close and trustful teamwork with several persons and groups of persons involved, among which the expert committee has the central position.

During almost one week's time we had the advantage of being together with the evaluation committee visiting research departments and field trials. The report was produced through intense work, during long days and late nights, when we also had the opportunity to discuss the environmental impacts of wood fuel harvesting in a broader sense with the evaluators. The content of the report, comments and assessments, are of course the responsibility of the committee.

We wish to express our sincere thanks to all participants of the scientific evaluation of the projects in the field of environmental impacts of wood fuel harvesting.

Stockholm, October 1995.

Bengt Boström
Head of Environment section

Hilmar Holmen
coordinator

Nina Österlund
project leader

CONTENTS

EVALUATION OF NUTEK PROJECTS ON THE ENVIRONMENTAL IMPACTS OF WOOD FUEL HARVESTING

1. BACKGROUND AND EVALUATION PROCEDURE

The Swedish National Board for Industrial and Technical Development (NUTEK) funds, among many other things, scientific research in the University sector in support of its task of considering issues connected with the growth and innovation of industry and the reorientation of the energy system. The reorientation of the energy system in Sweden since the oil crises of the 1970's has included an increased utilisation of forest biomass so that biomass from Swedish forests now accounts for some 15 % of the overall energy supply in Sweden. However, this increased utilisation of forest biomass has inevitable environmental impacts. In the context of the reorientation of the energy system, and specifically the increased utilisation of forest biomass, NUTEK has, since the early 1980's, supported four research groups working on the Environmental Impacts of Wood Fuel Harvesting. The projects considered in this evaluation form a part of the Swedish national bioenergy research effort. The overall objective of the research covered by the four projects is to assess the ecological and environmental effects of intensive harvesting and the impacts on long term forest yield.

The purpose of this evaluation was to inform NUTEK of the scientific quality of the research projects, as seen in an international context. The projects were therefore the main elements considered in the evaluation. However, the evaluation also considered structural problems which were relevant to the shaping of NUTEK's research priorities and funding policy in this particular area of research. The main basis of the evaluation was the scientific quality of the research and its relevance to NUTEK's aims in the application of industrial research and development. The basic principles applied in the evaluation are described in Appendix I.

Professor Hilmar Holmen was appointed as a coordinator, and Ms. Nina Österlund as a secretary of the Evaluation Committee. The following persons were appointed to the Evaluation Committee, based on suggestions made by the grant holders (see Appendix II):

Professor Mike Hornung, Institute of Terrestrial Ecology, England
Professor Seppo Kellomäki, University of Joensuu, Finland
Professor Jørgen Bo Larsen, The Royal Veterinary University, Denmark
(A list of the full addresses of the members of the Evaluation Committee is given in Appendix III.)

The present report is based on the information contained in the written reports submitted by the grant holders, site visits and discussions between the grant holders and the Committee. (The evaluation programme is given in Appendix IV.) The report first gives an overview and general recommendations concerning the overall programme on the Environmental Impacts of Wood Fuel Harvest. Thereafter, each projects are evaluated separately. The Committee was unanimous in its conclusions.

An overview of the NUTEK funding to the individual projects is given in Appendix V.

2. REVIEW OF INDIVIDUAL PROJECTS

Project number: Nutek Project 146 316-3

Project Leader: Tord Johansson
Swedish University of Agricultural Science
Department of Forest Yield Studies
S-750 73 Garpenberg, Sweden

Project Title: Analysis of alternative silvicultural systems for utilising hardwoods from first thinnings in Norway spruce (*Picea abies* (L.) Karst.) stands as fuel wood

---

1. Objectives

The study was initiated in 1983 with the aim of studying the growth and yield of admixtures of birch and Norway spruce when utilised for biomass production for energy generation.

The study is based on the hypothesis that over a complete rotation a properly managed birch shelter will yield about as much spruce as a stand from which birch has been totally removed. In addition, the project aims to determine the optimal management and utilisation patterns for birch and spruce admixtures used in biomass production while, at the same time, minimising long-term effects on site productivity. The study can be readily justified on theoretical grounds, by practical considerations concerning management of admixtures of different tree species, and in the context of the aims of NUTEK's research objectives concerning development of alternative energy sources.

The original main study was expanded during the project by the establishment of three linked subprojects, which deal with (i) the physiological response of Norway spruce to release from overstorey birch, (ii) damage and growth response of Norway spruce after removal of overstorey birch and (iii) utilisation of self-propagated birch in young stands of Norway spruce. These connected subprojects are important in explaining the response of the Norway spruce undergrowth to the removal of overstorey birch. However, the inclusion of such studies in the project should have been considered from the outset in order to make full use of the experimental sites and to allow the investigation of the mechanisms of acclimation of understorey spruce to the removal of birch shelter.

2. Approach and experimental design

The study has used an experimental approach, utilising long-term field experiments established in 1983-1985 in 20-30 year-old birch stands with spruce. Eight experimental sites were established in southern and central Sweden using an unbalanced block design aimed at studying the effects of seven different combinations of thinning (e.g. no thinning, line thinning etc.) and biomass removal (e.g. stem only, whole tree harvest etc.).

The number of replicates varies from one to eleven with the consequence that some treatment combinations are not replicated sufficiently to allow statistical analysis; this will limit the interpretation of some of the results. However, the field experiments provide a wide range of possibilities for the study of the questions addressed in the project. Model development is not considered within the project; however, modelling of the dynamics of the growth and yield of spruce and birch admixtures is essential if the findings of the experiments are to be generalised. Since the establishment, of the experimental sites, the measurements have been repeated every fifth year, the most recent measurements took place in 1994.

3. Results

The studies from the early 1980's are largely summarised in the Ph.D. thesis of Asa Tham, completed in 1988. Tham analysed the measurements made during the course of the establishment of the experimental sites and developed a growth and yield model which she then applied to calculate the growth and yield of spruce and birch admixtures. The model calculations support the claim that growth of Norway spruce under the shelter of birch is as high as from spruce stands with no birch shelter. The yield from the birch shelter represents a surplus, which increases the total yield from the stand, assuming stem only harvest of both species.

Comparisons with field measurements indicate that the situation could be reversed if whole tree harvest is applied; i.e. the removal of harvesting residue could reduce the long-term growth by as much as 20%. The overall risk of spruce mortality after release from the birch shelter was found to be small and mainly related to the weather conditions after the birch removal; these data are presented in the licentiate thesis by Annette Gnojek published in 1992. The linked sub-projects have not yet yielded results; the establishment of the experiments and the maintenance of the measurement programme have been the main activities since 1986. In practice, the linked subprojects are quite separate from the main project and, thus have only qualitative connections to the growth and yield studies. To bridge this gap, process-based modelling is recommended in any future studies planned on these or related topics.

4. Outputs

4.1 Publications

The total number of papers published from the project is 18. They are mainly departmental papers (14), for the domestic audience, rather than papers in refereed journals (4), for an

International audience. However, the main findings of the project have also been made available for the international audience in a doctoral thesis submitted from the project.

4.2 Contribution to practical forestry

The output of the project includes several papers for practical foresters. There has also been close collaboration with forestry organisations in planning and implementing the experiments of the project. This collaboration is important and will most probably increase the general acceptance, and incorporation of results from the work in the management of forests for energy production. However, the integration of the experimental findings in the form of a generic model, which can

be easily calibrated to specific conditions, should have been among the research priorities of this project.

4.3 Post-graduate training

Two post graduate theses have been completed using outputs from the project and a third is in preparation; if the third thesis is completed successfully all the research workers involved in the project will have obtained a post-graduate qualification.

5. Project management, external links and collaboration

Currently, the scientific staff of the project includes the project leader, with qualifications at the doctorate level, and one researcher, who is implementing the project (e.g. management of experiments, analysis, publishing) The project has been successfully managed within the constraints of the available staff, but more emphasis should have been put on publication to make available the massive amount of data collected.

The successful Ph.D. studies carried out in the project indicate a commitment to the long-term goal of maintaining and improving the scientific capabilities of the research staff; this is also indicated by the support to the Ph.D. studies of Hans Mard. However, the project has not been able to retain well-qualified staff, such as Asa Tham, and thus build a balanced and functional research group. This has most probably delayed the progress of the project. In addition to the NUTEK resources, the project has also been supported by the Swedish University of Agricultural Sciences and some private foundations. The project leader has also had many other commitments and this has probably had adverse effects on the management of this project.

The group has not developed strong international links despite the fact that management of mixed forests is of interest in a number of countries. The sites are being exploited by the group at Upsalla working on number 146 313-3 but we were unable to judge whether there was active collaboration between the two groups.

6. Relevance

The current model calculations indicate that properly managed admixtures of Norway spruce and birch most probably increase the productivity of the forest ecosystem with no significant risk for long-term productivity, assuming that stem only harvest is applied. However, there is a clear risk that overall productivity may be reduced if whole tree harvesting is applied. The project could, therefore be said to have answered the main question put at the beginning of the project. However, the findings require further assessment in the context of the available international literature on growth and yield of mixed stands.

Further, the project indicates that the profitability of forestry could be increased, compared to that of forestry using conventional practises, by appropriate management of mixed stands. This information is of strategic importance in meeting new challenges, such as the use of forests in energy biomass production, and the management the forest ecosystem on the sustainable basis. The integration of the research findings in the form of a generic model would have increased

substantially the relevance of the project as far as the management of the forest ecosystem for energy or timber production is concerned.

7. Future plans

The future plans of the project group have two main aims; (i) to study growth and yield in terms of biomass instead of volume and (ii) to study the effects of birch shelter on the mechanical and chemical properties of soil. It is also suggested that the optimal density of the birch shelter should be studied in parallel with the programme of regular measurements. The use of the experimental sites in studies on forest energy carried out by other research groups is also proposed; no specific plans for collaboration are presented by this group but the group at Upsalla have proposals for future work which would use the sites.

In general, the future plans of the project are not challenging or ambitious, indicating that the project has achieved the main goals set at the beginning of the project. However, the trials which have been established should be used as a basis for future interdisciplinary studies. For example, the trials provide unique opportunities to study wood quality (e.g. knots, juvenile wood) of both spruce and birch in relation to mixture and thinning. In this context, the development of a process-oriented model would be a great help in applying the findings in practical forestry. The sites also have considerable potential for broader ecological studies on, for example, the impact of mixed forest management on populations of birds and small mammals. This type of work is clearly outside NUTEK's research objectives but the availability of the sites should be communicated to other researchers and funding agencies.

8. Summary and overall assessment

The original aim of the project, to investigate the utilisation of mixed stands for the production of energy biomass has been achieved. The scientific output from the project is also reasonable as indicated, (i) the two doctoral thesis submitted from the project and (ii) the regular publication of papers and reports throughout the project. However, the number of papers published annually is smaller than one could expect and, furthermore, the majority of the papers are departmental rather than in international journals. Hence, the main part of the findings of the project has fallen outside the discussion and critique provided by publication in an international audience. This lack of international peer review should be kept in mind, when applying the findings of this project.

The project has been largely carried out in isolation with few domestic and international contacts to research groups working on similar problems. Closer collaboration with other NUTEK projects should be encouraged if the project is funded further in any form. The project group should be strongly encouraged to publish for the international audience; many of the findings achieved so far are at the same time unique, in that there are no other similar datasets available, and relevant to forest management in Nordic countries and outside. Continued support for the project over the short term is justified to enhance the publication, for example, and to ensure the completion of the doctoral thesis of Hans Mard; this latter will require well organised supervision and a strong commitment to complete the thesis in the near future. The completion of the thesis is probably the best way to make available the results from the remeasurements. The maintenance of the experiments and the establishment of new ones with broader scientific aims fall outside the area of interest of NUTEK, and these activities should be funded through other sources.

Project number: **NUTEK project 146 313 - 3**

Project leaders: **Helene Lundkvist and Jan Bengtsson.**
Swedish Agricultural University
Upsalla

Project title: **Effects of whole tree harvesting on long term site productivity**

---

1. Objectives:

To investigate the effects of whole tree harvesting on forest soil productivity and stand development with the emphasis on soil nutrient dynamics and soil acid - base status.

Within the above broad objective, the project has focused on the impact of whole tree harvesting (WTH) on :

C sequestration
N availability
soil acidity
field vegetation
soil organisms and soil food webs.

These themes have effectively formed separate sub-projects.

2. Approach and experimental design

The project has used a combination of modelling, field experiments and short term laboratory studies. The C stocks and site productivity work has used a combination of modelling and field data; soil acidity and base status, field derived data; N availability, field data, laboratory experiments and modelling; field vegetation, field data; soil organisms, field data.

The main field experiment, initially established between 1974 and 1976, uses four sites, two in southern Sweden and two in northern Sweden. A randomised block design is used at each site with four replicates of three treatments: conventional clearcutting, removal of all above ground tree biomass (WTH), WTH but with needles left on site. Two of the sites were replanted with pine following harvesting and two with spruce. More recently, additional work has begun on sites which form part of a study of utilisation of hardwoods from mixed spruce - birch forest (cf project 146 316-3); the emphasis of this study is the impacts on soil acidity and nutrient status.

The field experiments are well designed with a good level of replication. The design of the individual studies/subprojects and the constituent sampling programmes is also good; the sub-projects have clear, achievable aims. There should be no problems in statistical analysis of the data to detect any impacts of the treatments. The modelling, field experiments and laboratory studies are clearly interlinked.

The design will, however only allow the impacts of WTH on "forest soil productivity", "soil nutrient dynamics" and "nutrient flux" to be explored in a limited way. The project has not quantified all the main nutrient pools or fluxes: the contents of nutrients in roots, ground vegetation and the current rotation trees, and fluxes from weathering and in drainage waters, for example have not been quantified.

A nutrient budget cannot be formulated. Evaluation of long term impacts would require additional input data for the existing model. A nutrient budget approach should be explored as an alternative method for the assessment of impacts on long term productivity; this would require additional nutrient flux data from the early and later stages of the post-WTH rotation and would have to be carried out in the context of specified scenarios of atmospheric inputs of pollutants and base cations.

The group seemed to have access to adequate facilities. Within the context of the current aims and objectives, the work was not being held back by lack of equipment or staff resources.

3. Results

C stocks: this aspect of the work is based around a model developed by Agren and Bosatta (1987) plus empirical, measured data from the four main study sites. The modelling studies predicted a decrease, following WTH, in productivity as measured by stem production but an increase in overall harvested biomass (depending on site type), and a small decrease in soil C. The results from the field studies showed no treatment effects on soil carbon stores at the four sites. Both the modelling and empirical results show the main impact on soil C stores resulted from harvesting not harvesting intensity.

The modelling and empirical work have been linked well in this part of the study. Current work is collecting further data to allow improved parameterisation of the model and some improvements. As noted above, the evaluation group had some reservations about the evaluation of impacts on long term productivity based entirely on the existing model.

Soil acidity and base cations: modelling suggests that WTH would increase proton load, as a result of increased base cation removal, by 2 to 3 times compared with conventional, stem only harvest. The results from the field studies generally support the model predictions, a reduction in soil pH, compared to conventional felling of 0.2 to 0.4 units and an increase in exchangeable acidity/reduction in base saturation in the L and FH layers; the measured increase in exchangeable acidity was less than predicted. The largest reduction in base cations was in Ca and Mg. There was parallel reduction in Ca:N, Mg:N, and Mn:N in needles after WTH. These are useful data, providing a test of model predictions, but further sampling at a later date is recommended to evaluate longer term trends.

Field vegetation: clear differences in ground vegetation were found between treatments and over time. There was an increase in grasses, mosses and lichens, and a reduction in Vaccinium in WTH compared to conventional felling. The main impact was related to the nutrient input from slash rather than the physical effect. The analytical methods used to-date are supported but assessment using plant strategy models might provide additional insights. The data should also

be related to the extensive datasets which the evaluation group heard about from the other projects.

Soil fauna: WTH resulted in a reduction in fungivores, predators and Diptera but no changes in enchytraeids or nematodes. The changes were quantitative rather than qualitative. The long term effects of the changes in nutrient dynamics are unclear. There are few good datasets on the impacts of forest management on soil biota and the evaluation group were impressed with this work. An evaluation of longer term trends would be valuable and the analysis of the impacts of the changes in population size on long term nutrient cycling.

Nitrogen availability: Field and laboratory incubations have shown no differences in N mineralisation between treatments. Studies reported in the literature have shown clear differences in nitrification between conventional and whole tree harvest in the first few years after felling; the apparent changes in response over time should be investigated.

4. Outputs

4.1 Publications

The project has produced 21 papers in refereed journals (Excluding refereed conference proceedings), 16 in non-Swedish journals over a period of 11 years. This output of refereed papers in international journals, c. 2 papers per year, is good , although not outstanding when compared internationally, and compares very favourably with the outputs from the other projects evaluated. A number of the published papers were also in high quality journals. We are confident that the group will be able to achieve a higher output of papers, indeed they expressed the view that they needed to write-up more of their work and had a large number of papers in preparation. The evaluation group recommend that the group be encouraged to concentrate on publishing in international journals for the next few years.

4.2 Science contribution

The project has provided additional information on the impact of forest management on carbon stores, site nutrient status/acidification, vegetation and soil fauna which is important in its own right but which also provides an important resource for model development and testing. There are, for example relatively few examples of soundly based quantification of impacts on soil C stocks. It has also addressed some important processes but some of the process-related interpretations require testing. The soil faunal work is making an important contribution to basic science, forming the basis of the development of food web theory.

4.3 Contribution to practical forestry

The practical aim of the work was expressed by the project leader as, "to contribute to the improved recommendations on ecological restrictions for WTH." The work will certainly contribute to the development of an informed debate on the ecological and environmental impacts of WTH. It has allowed model predictions of the impacts of WTH on soil C stocks and base cations to be tested. It should also contribute towards the development of improved, ecologically based guidelines for the application of WTH. The challenge, however is to develop generalised

models which can then be applied to specific sites. We are not convinced that the work has reached that stage.

4.4 Contribution to post-graduate training

Three doctoral theses have been prepared by research assistants working on the project and the group has therefore made a valuable contribution to post graduate training. Each of the theses has given rise to papers in refereed journals.

5. Project management, external links and collaboration

The current project team comprises the two project leaders, two research workers and technical support. The group seemed well led, was enthusiastic and had clear goals. It appeared a genuine team with good interaction between members of the group but with each member having a clearly identified role.

The group had developed links with researchers in other departments in the Agricultural University, with other universities in Sweden and with overseas groups. The latter links had been partly facilitated by involvement in an EU COST exercise and in the IEA/BA - T9 activity 4 on the "Environmental Consequences of Intensive Harvesting." Jan Bengtsson had also spent a short period at Imperial College, London. The evaluation group did not feel able to assess how active all the links were was, however we were concerned about the level of genuine interaction with the Umea group (Project 146 312-2).

The group had a good awareness of the international literature and of current developments in methodologies and approaches. The work had been presented at six international conferences over the last five years.

Our only reservation concerns the groups links with practical forest management; we feel links of this type should be strengthened to ensure the translation of the results into practical forestry.

6. Relevance to NUTEK'S aims

NUTEK's aims for its programme of work on the environmental impacts of baffle harvesting in forests include consideration of the effects on site productivity, acid/base status of soils and the supply of base cations in soils. This project has contributed in each of these areas. The current phase of the project has as its overall aim the contribution to the development of recommendations for WTH and any necessary compensatory nutrient additions. The project will contribute to this aim but will not yet allow generalised models to be developed.

7. Proposals for future work

(a) Impacts at clearcutting: we would support this proposal as part of an attempt to use a nutrient budget approach to assess the impact of WTH on long term productivity as reflected in soil nutrient status; this approach would run in parallel to the modelling under (d) below and to the evaluation based on field data on production. The development of nutrient budgets would also require data on weathering rates and variations in atmospheric

inputs over time; this would require the development of links with other groups with the required expertise. We also recommend that an evaluation first be carried out of the available data from the international literature, prior to the initiation of new field studies, so that some targeted process work can be incorporated in any continuation of this work.

(b) Effects on soil organisms: we support this scientifically exciting and challenging work but recommend that the assessment of the impact of the detected changes in population size of the fungivores on long term nutrient dynamics should be linked to attempts to incorporate these aspects into models; there is also scope to incorporate laboratory based work.

(c) Environmental effects of WTH in a large scale perspective: a high priority should be given to the collation and synthesis of all available data so that generally applicable models can be developed; we would support the use of a budgetary approach but are not convinced that the necessary data is available; it should be possible to develop statistical, empirically based models. This work should be carried out in isolation but rather in collaboration with other groups with related datasets.

(d) Mixtures of spruce and birch: the proposed work on the impacts of variations in density of birch on soil properties would be worthwhile if the exploitation of mixed spruce-birch forest is considered a realistic possibility.

(d) Modelling long-term effects of WTH on C and N dynamics: this work has already been started and we support its continuation and development, however, it is important that attempts be made to incorporate other nutrients into the models or to apply other models which include Ca, Mg and P.

8. Summary and overall assessment

The project has produced results which both contribute to the development of recommendations for forest practice and to general advancement of science. An active and productive research group has been created which has published its results in the international literature and achieved international recognition. The work could certainly be graded good in an international context with some aspects very good. We have concerns, however about the true extent of the collaboration with the groups involved in the other projects evaluated and with practical forestry practice.

9. Reference

Agren, G.I. & Bosatta, E. 1987. Theoretical analysis of the long term dynamics of carbon and nitrogen in soils. Ecology, **68**: 1181-1189.

Project number: NUTEK project 146 312-2.

Project leader: Bo Leijon
Swedish University of Agricultural Sciences
Department of Silviculture
Umea

Project title: Effects of whole tree utilisation on forest yield

---

1. Objective

To evaluate the consequences of whole tree harvesting (WTH) on forest growth and yield.(WTH is here used for removal of all above ground biomass).

2. Approach and experimental design

The study is based on empirical, measured data from a series of field studies and has examined regeneration, short term growth changes and long term site productivity as indicated by stem and total biomass production. Combinations of site type, species and harvesting intensity have been used. One series of four sites is described under the report on project 146 313-3. The sites in a more extensive series, of c.30 sites, generally have two replicates of one or two treatments; the treatments always include conventional felling and removal of all above ground biomass.

Since 1991, the project has been divided into five sub-projects which relate to the main research topics:

-Effects on seedling survival and initial growth
-Interactions between harvesting residues, seedling performance and seedling environment
-Short term effects on growth of WTH in thinning operations
-Long term productivity changes.
-Effects of increased harvest intensity on forestry practice.

The different sub-projects use all or a sub-set of the series of experimental sites. The experimental design, the level of replication and the plot size, particularly of the four intensive sites, allow the research questions to be addressed and treatment differences to be statistically assessed. The plots are large enough to allow long term work on the trees of a central, core area within each plot.

3. Results

3.1 Effects on seedling survival and initial growth

Data from 33 sites show increased seedling survival following WTH, compared with conventional felling or removal of slash minus needles. The effects were small but it was concluded that the increased stand density, resulting from increased seedling survival, could lead to a higher yield potential and, possibly higher wood quality thus offsetting any reduction in

production resulting from brash removal. The conclusions, based on such a large number of sites across a range of site types provide valuable empirical data with relevance for practical forestry management.

3.2 Interaction between harvesting residues, seedling performance and seedling environment.

The NUTEK funding would seem to have been used to establish study sites but the actual study is being carried out outside the NUTEK project. Results to-date suggest that vegetation dynamics, initial growth rate of seedlings and seedling mortality resulting from weevil attacks are little affected by harvesting residues. The result concerning vegetation dynamics differ from almost all other related published work which, in general show clear differences in response to brash removal; the results from the current study should be assessed alongside published material to investigate the factors controlling the differences in response between sites. The sub-project does not relate clearly to the impacts of WTH and the evaluation group were unclear about the links between this work and other studies in the NUTEK project. However, the study is potentially valuable because it is one of the few which have data on the brash cover adjacent to individual seedlings. A more detailed analysis of the available data should be carried out.

3.3 Short term effects of WTH of thinnings

This sub-project has examined growth after WTH of thinnings and the impact on growth of fertilizer additions following the WTH. A reduction in growth as a result of WTH has been shown but this is considerably smaller than the reduction in growth reported from Nordic studies examining the impact of WTH at clearcutting. The results, if widely applicable have important implications for the development of guidelines for the implementation of increased biomass removal.

3.4 Long term productivity changes

Stand level data on tree growth have been analysed from a large number of sites. The results have been interpreted as suggesting that there will not be long term impacts on growth as a result of brash removal. The evaluation group were not able to evaluate all the information but data presented from the Lovliden site showed an impact on height growth over the period 8 to 26 years after felling although there were indications that the differences in height increment between treatments had declined in recent years. It is important that these empirical data are examined alongside the outputs from the Agren and Bosatta model as the results are apparently contradictory; the empirical data should be seen as a test of the model. While there is a need to continue monitoring growth at some of the sites over the longer term, the controls on responses also need investigation. It is also important that the cause of the deficiency symptoms at the Lovliden site be investigated and that the underlying reasons for the onset of the differences in growth between treatments at c. year 8 be determined.

(e) Incorporation of the effects of increasing harvesting intensity into "models" of forestry practice.

This sub-project seeks to develop and evaluate models for the incorporation of intensive harvesting into forestry practice and to evaluate the models in an economic context. The model

seeks to incorporate the several, sometimes confounding effects of intensive harvesting. (Model is not used here to describe a mathematical relationship but rather a management schema). The development of practical forestry management procedures for the implementation of more intensive harvesting is central to NUTEK's aims. The collaborative study funded by Forestry Canada has provided a useful review of available literature on the impacts of WTH, at final harvest and thinning, on growth and yield. A desk study of a model system, carried out as part of the collaborative study, suggests that the increased income from the additional biomass removed in intensive harvesting offsets any reduction in income due to reduced yield. We recommend the further incorporation of economic considerations into the evaluation of impacts of WTH.

4. Outputs

4.1 Publications

The group have not to-date published any of the work from the project in international refereed journals. Much of the work is suitable for publication and should be made available to the wider scientific community. In the immediate future the group should concentrate on analysis, synthesis and publication of existing data. We were assured that a number of manuscripts were currently in preparation; the highest priority must be given to seeing that these are completed.

The results of some of the work has been reported in internal documents or reports published by the Agricultural University. These have made some of the information available within Sweden and hence to the national forest management community.

4.2 Contribution to science

In the absence of publications the group has made a limited contribution to the scientific community. However, the studies have provided important new data which should be made more widely available; the databases are a very valuable resource for model development and testing, in addition to the development of practical guidelines The lack of research designed to determine why particular responses occur limits the development of generalised relationships.

4.3 Contribution to practical forestry

The project has, and is making an important contribution to the development of practical recommendations and prescriptions for forestry.

4.4 Post-graduate training

There have been no doctorate theses completed on the project todate but one is currently in preparation. A high priority should be placed on completion and submission of this thesis.

The members of the research team are actively involved in undergraduate teaching and in courses for foresters.

5. Project management, external links and collaboration

The team currently comprises the project leader, two research workers and technical support. The level of activity on the project has been affected over the last two years as a result of illness and the absence of one of the team on other work in Africa.

The research group and the consultative committee are enthusiastically committed to their research but were also surprisingly defensive about their work, seeming to see other groups as threats or competitors rather than potential collaborators. There seems to have been a tendency for the group to spread its efforts too thinly, initiating new work before completing the detailed analysis of existing studies. The group needs more positive leadership and clearer goals; these goals should be developed in discussion with NUTEK. The empirical orientation of the research reflects the background and training of the group members in practical forestry; such research is valuable but the group also need to develop closer links with researchers experienced in process/mechanistic studies.

The team has good links within the Umea campus but the evaluation group were concerned about the nature of the interaction with the group in Uppsala. There were few international contacts but the link with the University of Moncton, Canada, funded by Forestry Canada had been very profitable. We recommend that NUTEK consider funding the short term involvement of overseas collaborators on specific topics.

The group appeared to have a limited knowledge of the relevant international literature and did not seem to realise that it had much to contribute to the international scientific community.

6. Relevance to NUTEK's aims and to the contract

The project has contributed to the assessment of the effects of intensive harvesting on biomass production and on site productivity and is therefore directly relevant NUTEK's research aims. The main objectives of the research contract, as set out in 1 above, have also been addressed but the value of the work cannot be fully assessed until it has been subjected to international peer review.

7. Future proposals

7.1 Harvesting residues and forest regeneration

The proposal would focus on the seedling environment. It would seem that this type of work is currently being carried out outside the NUTEK contract. Is this proposal designed to bring it within the project? The study could provide the basis for interpreting the controls on seedling response and therefore for the development of generalised relationships. We are not convinced that the current group has the expertise to carry out this type of work they would, therefore require inputs from outside the group.

7.2 Maximum harvest intensity

The evaluation group feels unable to support this proposal. It is interesting scientifically but it would be preferable to invest in research on key controlling processes with the aim of developing generally applicable models.

7.3 Translation of results into forestry practice

This is one of the main aims of the NUTEK funded research. The challenge is to develop generally applicable models/relationships. The development of such generally applicable models need can be based on statistical relationships developed from large datasets or on mechanistic models. The group have large datasets which could form the basis for the development of statistical relationships. However, the required level of understanding of mechanisms is not yet available for the development of mechanistic models. This group should concentrate on the development of statistically based models. Any development of practical prescriptions should take account of the results of all the work carried out under the projects evaluated here and not of this project in isolation; we recommended that this proposal only be supported on this basis.

8. Summary and overall assessment

The group has a large number of valuable research sites and has developed extensive and valuable datasets. The available data have not, however been analysed in detail; this analysis must be a high priority. The work of the group must also be published to allow peer review of the research and to make the data available to the wider scientific community. Because of the lack of publications in the international literature and the limited external contacts, the project up to now can only be described as poor, using the NUTEK criteria. However, we feel it has the potential to reach a higher standard if the group focuses its activities more and publishes its results.

Project number: **NUTEK project 146 315 - 3**

Project leader: **Lars Kardell**

Project title: **Nature conservation - forest fuel**

---

1. Objectives

The objectives of the project were to study the effects of increased biomass extraction through stump and slash removal upon:

- long term site productivity,
- production of berries and edible mushrooms,
- development of the forest flora, and
- the public reaction/acceptance in relation to recreational values.

2. Approach and experimental design

The project has used an empirical approach based on field studies. A series of experiments have been laid out:

-9 experiments with stump and slash removal distributed over the most important forest sites in Sweden; each site includes 4 treatments with two replicates of each treatment. The development of flora, berries, and in parts edible mushrooms have been studied during the first 10 years after establishment;

-7 excavation experiments, where the uppermost 20 cm of the forest soil has been removed from one plot and placed upon the surface of another adjacent plot. Flora and berry production were recorded annually over a period of 10 years;

-4 experiments with stump extraction spread out over Central Sweden (two replicates of each treatment); flora and berry production were monitored over a 10 year period;

- analysis of vegetation composition and forest production in relation to earlier disturbances such as forest fires and humus removal due to gravel excavation.

In addition, in two major forest regions the public attitude, in the context of recreation, to stump and slash removal have been investigated twice at an interval of 12 years by means of measurement of the response of different groups (Osgood-test).

3. Results

3.1 Long term site productivity

No far reaching conclusions can be drawn, mainly due to the short period studied (9 years). Reduced growth after forest fires has been recorded for spruce but not for pine. A 10 % lower growth on former gravel pits underlines the importance of the humus for productivity. However, the study has only limited potential in the identification, and quantification of the processes controlling the impact of stump and slash removal on long term site productivity.

3.2 Production of berries and edible mushrooms

The three most important berries reacted differently upon slash removal: whereas raspberry was affected negatively, blueberry and lingonberry reacted with increased production during the first years. The stump extraction had a negative influence on the production of all three berries. The results, however, give only limited information in respect of the regeneration of the three species and therefore little indication of the influence on the long-term production of berries.

3.3 Development of the forest flora

In general vegetation damage after forest operations heals only slowly, but, due to invasion of a number of new species, the species diversity is somewhat greater on disturbed forest sites, even after 50 to 100 years. The results, however, only give information on diversity in relation to quantity and not to quality in terms of authenticity, as related to diversity in natural old growth forest. Further, they are primarily focused upon higher plants. Hence, they are of limited interest from the perspective of more general biodiversity. In our opinion the vegetation data need to be analysed in more detail, for example using more advanced (multivariate) statistics or alternative methods of vegetation analysis

3.4 The public reaction/acceptance in relation to recreational values

The results show that human perception/acceptance of changes in forest operation change alters with the individual or group's level of knowledge about natural systems and processes. The author concludes, that those manipulations connected with the increased use of forest fuels, and which here considered in the survey, will have little impact on recreational use of the forests. We do not, however, have the experience or expertise to allow us to judge the results and the way they are analyzed. From our admittedly limited perspective, we suspect that the sample of people used in the exercise was probably biased; the method of analysis used also seems rather simple.

4. Outputs

4.1 Publications

In the report the author presents a list of 20 publications based on the research .We found it difficult to assess which and how many of these are directly related to the NUTEK-project.

Approximately one third were published prior to the present project period, and some are indicated as having had financial support from other sources.

All but one (published in 1978) of the publications from the project are written in Swedish and published in internal reports or in local journals with a popular profile.

4.2 Contribution to science

Since no results have been published internationally, the contribution to the international scientific community is limited or non existing. It is our opinion, that the results in part are of scientific interest and deserve to be made more widely available. In order to be acceptable for publication in international journals, however, the data will need to be subjected to better analyzed and broader discussed more fully in relation to international literature. Further, we formed the impression, that a lot of data, especially in relation to vegetation changes and development after soil excavation and stump removal are still unpublished. Results from these experiments could be scientifically significant and should be published internationally.

4.3 Contribution to practical forestry

The project leader has published extensively in different Swedish journals and in the form of information leaflets and has, therefore done a very good job of translating the results of the project into practice.

4.4 Post graduate training

Two post graduate students have been employed by the project, however, both finished before taking a Ph.D-degree.

5. Project management, external links and collaboration

The project is strongly centered around the project leader, mainly due to lack of continuity among the Ph.D.-students. The group is not internationally linked and seems to be rather isolated in relation to the other NUTEK grantholder. It is our opinion, that the "group" needs input and inspiration from outside.

6. Relevance to NUTEK

The achieved results concerning the possible negative effects of increased biomass removal for energy production are of limited interest due to the above mentioned experimental weaknesses. The analysis of the effects on production of berries and edible mushrooms might be of direct interest and should be used in socio- and resource-economic modelling.
The results concerning vegetation changes are of relevance but need to be better analysed and expanded to embrace other taxa including cryptograms as well as other species related to seral and late successional stages.

7. Future plans

As pointed out above, large amount of data - partly unpublished and partly published locally after being preliminary analyzed - urgently needs to be analysed and published internationally. In accordance with the suggestions of the project leader, we feel that this task the highest priority in the immediate future. To fulfil this task. however, it is our impression, that the group needs some support, especially on data analysis and statistics.

We agree about the importance of analysing the role of old stumps and dead wood "for the survival of cryptograms and small animals". Such studies, however, should be expanded generally to analyse key taxa and species characteristic of seral stages, but we question whether this group alone might have the competence to do this work. The field experiments which have been established are of high value for further studies in biodiversity.

Further investigations of the consequences of increased biomass utilisation for long term productivity must have a high priority. In this context some of the trials already established during this project might be an important resource for further research, especially the excavation experiments. The scientific approach suggested by this group should be expanded by attracting other research groups to work on these sites in order to get a more basic understanding of the processes responsible for short and long term growth reductions.

Further studies on mushrooms should be directed towards species, which are important for ecosystem processes and functioning, in this context mycorrhizea are of special interest. The study of tree-fungi relationships in terms of mycorrhizea requires a specific competence, however and might not be within the direct scope of the NUTEK programme.

8. Summary and overall assessment

The original aims of the project have been achieved in part. A series of interesting sites and experiments have been established which have a high value for future research in this field. The project has, more importantly lead to a better knowledge of the impacts of increased biomass utilisation on forest flora, berry production and the production of edible mushrooms. Furthermore, an insight has been gained of the public perception and acceptance of intensive harvesting methods. However, the project has provided only limited information on the impacts on long term productivity.

The research group has, upto now been rather isolated nationally, with no international publications or links. From a scientific point of view, output therefore been rather poor. The group urgently need to be integrated nationally and internationally.However, the links with practical forestry are well developed and some of the achievements can easily be translated into silvicultural practice.

3. GENERAL CONCLUSIONS AND RECOMMENDATIONS

1. Introduction

The projects under evaluation have yielded some high quality work, established some excellent research sites with a range of treatments and a good level of replication, given rise to some very valuable data sets and produced both applied and more basic science outputs. The studies also include a combination of empirical field studies, modelling and laboratory investigations and strong links between practical silviculture and more fundamental research; combinations and links which are essential in this type of research.

The results from the projects, when fully analysed could form the basis for the development of practical prescriptions for the management of forest systems for increased biomass production. The results also have a wider relevance in more conventional forest management and in the understanding of the functioning of forest ecosystems. The quality of the work and the level of output is however variable across the projects and the different approaches to the research have not been adequately linked; these problems and the limitations which produced them should be considered when forming any new research programme.

As noted above, the projects have produced a very valuable series of well planned and designed long-term sites which are of national importance and international significance. We recommend that sources of funding be sought to maintain these sites and to ensure there continued availability to this and a wider research community. We realise that such funding falls outside the remit of NUTEK and that a consortium of funding agencies may have to be developed.

In making our overall comments and recommendations, we realise that the current research programme is coming to an end and that NUTEK are currently considering the focus and structure of a possible further phase of the research. It may, therefore be considered more appropriate to act on our comments and recommendations in the context of the next phase of the research/new project rather than to modify procedures in the short period remaining of the current projects.

2. Scope and aims of the research

Until now, the projects have mainly focused upon the environmental impact of intensive harvesting in terms of the impact on long term site productivity, which is closely linked with the biogeochemical cycling of nutrient elements. As a consequence of the international development of guidelines for sustainable forest management following the UNCED-conference (Rio) and the Helsinki-process, the definition of sustainability has been expanded not only to safeguard the sustained production of wood but to secure the basic functioning of the ecosystem including all its inhabitants. In this context the protection of biological diversity will play an important role in future forest management. We therefore recommend, that any future research of this type include a more general consideration of biodiversity. Such studies may well fall outside the scope of NUTEK's funding but it is important that they are supported, perhaps within the broader Swedish programme of environmental research; we therefore feel it important that other potential funders of this aspect of the work within Sweden be informed of the NUTEK research programme and of the opportunities presented by the research sites.

There is a need to determine weathering and atmospheric inputs of base cations at the main research sites, since they are crucial for the long-term carrying capacity, and to enable a nutrient budget approach to be used to assess long term site productivity. Further, data on root biomass and root distribution as well as nutrient stock in tree crop should be obtained.

The real challenge of the research programme is to derive generally applicable conclusions, models and management guidelines. This will not be achieved by an empirical approach alone. Some groups put their faith in ever larger arrays of field sites. A network of sites on a range of site types is important but there is also a need for some well designed experiments which focus on key, controlling processes; a better balance is required between this approach and the more traditional silvicultural approach. A series of "models" is required, including empirically derived relationships, management prescriptions, nutrient budget models and dynamic mechanistic, or process-based ecosystem models and resource-economic models. Some of these approaches will require inputs from groups who are not currently involved in the project.

3. Collaboration and leadership

The four projects evaluated are currently functioning in parallel with little true collaboration. The use of common sites has not produced strong links between the groups. The lack of collaboration seems to be due to a combination of factors: physical separation of the groups, conflicting loyalties (to their home institution rather than the research programme), differing research cultures (silviculture vs. biology/ecology, practical vs. management, empirical vs. modelling), as well as conflicting personalities.

We also recommend that the research groups be brought together annually to make presentations of their respective results to each other (and NUTEK), to discuss interpretations, and to jointly identify current uncertainties and gaps in knowledge.

If the research is to be carried out in a number of small teams, the leadership of those teams is very important. The standard of leadership has clearly varied between the projects. It is important that NUTEK has confidence in the leader, the continuity of leadership and that the leader can commit the necessary time to the project before it agrees to continued funding.

Some of the research groups involved in the current projects have few international contacts with groups working on related topics or with complimentary expertise. We consider such links are vitally important and recommend that NUTEK pay particular attention to a group's international links when considering future funding. We further recommend that NUTEK consider making small grants to contractors to fund short visits to related, international centres of excellence or for leading international workers in related fields to visit the groups for short periods.

4. Progress monitoring

There is a lack of focus in the research of some of the groups and a tendency to initiate new work before completing and analysing existing studies. We recommend that more clearly defined research goals, with annual "milestones", are identified by NUTEK in discussion with the research groups. Closer monitoring of progress against these agreed goals is necessary in this and any similar future research programme.

5. Dissemination of results

The criteria suggested by NUTEK for grading the projects/research groups emphasise the international standing of the work. If the work is to be judged in the international arena, NUTEK should make publication in international journals a requirement for continued funding. However, we recognise that in some cases NUTEK may fund work which, although of high quality, will not lead to journal papers; in these cases, this work must be judged by different criteria. We also recognise that it is important that the results of the work, especially the applied aspects, are disseminated via popular publications and that the research groups should receive credit for such publications. However, almost all the work we have evaluated could and should have led to journal papers as well as popular articles.

6. A new co-ordinated research programme

The environmental impact of increased biomass extraction is an important research field in the context of Swedish energy policy, specifically in the context of the stated intention to develop effective and environmentally-friendly, renewable energy technology. We therefore strongly recommend, that the current research funding should be followed up by means of a long term coordinated research programme, within NUTEK's R and D portfolio.

However, an integrated approach, linking the projects/sub-projects within the research programme is needed if NUTEK is to derive the full potential from its research investment. The science also requires integration and linkage. Thus, for example modelling and empirical approaches should be seen as complementary. We recommend, therefore that an overall conceptual framework should be developed for the research programme which links the constituent projects and sub-projects.

NUTEK should aim to ensure integration from the start of the new research programme, to build the new programme on a foundation of the results from the current programme and the best of the current projects, and to ensure participation of the best available researchers within Sweden. To achieve these aims we recommend that a research plan be developed, based on an overview of the results to-date and the relevant international literature, and that a programme committee be formed to oversee and monitor the implementation of the plan and the constituent projects. We recommend the following stages in the establishment of the research projects and contracts:

- publication of a summary of the research plan with a call for expressions of interest in carrying out research on specific elements of the plan,
- an evaluation of the expressions of interest, by the programme committee,
- invitations to selected groupings, based on the evaluation of the expressions of interest, to produce detailed, integrated research proposals which would form sub-projects of the research programme,
- award of contracts with clearly defined annual goals and with specified allocations to the different components of the work covered by the individual sub-projects,

- monitoring of the programme by the programme committee,

- a conference at the end of the programme to present the results to the wider scientific and forestry communities.

Appendix I

Invitation to participate in the evaluation of Swedish research projects in the field of Environmental Impact of Wood Fuel Harvesting

Dear Professor Mike Hornung/Professor Seppo Kellomäki/Professor J. Bo Larsen,

The Swedish National Board for Industrial and Technical Development (NUTEK) hereby invites you to be a member of an international evaluation group.

NUTEK answers to the Ministry of Industry and Trade. Its main activities are presented in the enclosed booklets. The main performing sector for NUTEK, according to research and development support, is the University sector.

NUTEK has supported four research groups in the field of Environmental Impact of Wood Fuel Harvesting since the beginning of the 1980's. (see Enclosure 1). These projects are a part of the Swedish national bioenergy research efforts. The objective to support this research field is to make clear the conditions for increased wood fuel harvesting and the effects on the environment, i. a. on soil fertility and on forest yield.

As the Swedish scientific community is small it is important to evaluate the research activities in an international context, primarily from a scientific point of view, but also to which extent they are related to industrial development and applications.

For each scientific field to be evaluated, a group of experts is formed. The group is composed of scientists from abroad who are able to judge the research projects in an international perspective without influence on considerations on the national level. NUTEK attaches considerable weight to the advice given by such foreign experts (see Enclosure 2).

The purpose of the evaluations is to inform NUTEK about the scientific quality of the research projects, as well as the groups, seen in an international context. The projects are thus the main elements entering into the evaluation. However, the evaluation group is free to comment also on structural problems. The evaluation should be forward-looking where possible, and the reports are important elements in the priority considerations of NUTEK. (An example of an earlier evaluation report is enclosed).

In consultation with Swedish researchers your name has been suggested and on behalf of NUTEK we hereby invite you to participate in the evaluation. We sincerely hope that you will participate in the evaluation group and that you are able to come to Sweden **25-30/9 or 2-7/10 1994.**

Please answer as soon as possible if you accept to participate in the evaluation group and which week you prefer or weeks possible for you to come.

Please answer by telefax +46 8 681 93 28 attn, Nina Österlund.

In late June we will send you information in English regarding the research projects that are to be evaluated.

The present paper describes the evaluations and the general framework for their execution.

Organisation of the work and other procedural matters

The composition of the evaluation group is based on suggestions from the researchers. The group itself decides on the distribution of work among its members. Normally, the scientific reports are distributed to all of the members. During the week in Sweden project site visits are made, as well as the drafting of the joint evaluation report.

Collection and distribution of basic documentation

Every research project supported by NUTEK has a principal grant holder who is responsible for the project. These grant holders are requested by NUTEK to submit scientific reports and other documentation on which the evaluation shall be based. The points below describe what might be asked for in such a request. Details may, of course, change depending on the subject etc.

* A short description of the project.
* A summary of the results of the project.
* A summary of the resources (supplied by NUTEK and by other sources) available for the project .
* A prognosis on the future development of the project in terms of objectives, resources, time schedules etc.
* A complete list of publications relating to the project. The five (or ten) most important publications shall be attached.
* A summary of examinations, dissertations for the degree of PhD etc within the project.
* A short *curriculum vitae* for the principal grant holder.
* A summary of those current activities of the principal grant holder that fall outside the scope of the project(s) of the present review.

All this documentation will be sent to the evaluation group members not later than four weeks before coming to Sweden.

Project site visits

As a complement to the examination of the written material, the evaluation group is invited to pay visits to the departments where the projects are running. Hearings with the grant holders and the members of the research teams are important elements of such visits.

Aspects to be covered in an evaluation

The documentation provided by the project grant holders and the project site visits together form a basis of the evaluation . The following paragraph lists the aspects or questions which one would like to see addressed by the evaluating group, when it reviews individual projects. The group is of course free to modify the scheme where necessary.

* The scientific quality of the results obtained.

* The scientific value of proposed projects (including the question of possible improvements by changing the aim and the direction of the project).

* The merits of the methods used and proposed.

* The capability of the project leader and the staff (including issues such as size and composition of the group).

* The adequacy of existing and proposed research positions, facilities and equipment.

* Other considerations or viewpoints which may be of importance for the projects.

* Views on the NUTEK efforts on Environmental Impact of Wood Fuel Harvesting at the prospect of a planned programme set up.

* The question of increased, unchanged or decreased support. Termination of projects (constructed alternatives if possible).

Report of the group

The work of the group shall result in a report to NUTEK. Preferable, this report should comprise a section with comments on the general scientific level of the research performed, including discussions of structural and organisational problems. The need for expensive equipment and other points of general relevance could also be raised here. Another section should deal with each project individually as outlined above.

In order to standardise the terminology used in the assessment of the individual projects, the following grades could be used:

Excellent - represents research at a very high international level with publications in internationally leading journals; the researchers are among the leading in the field.

Very good - represents research at a high international level; the researchers are among the leading in the sub-field

Good - represents research at a good international level ; the researchers have a good international reputation within the sub-field

Fair - represents research that only partly is of good international level and only partially published in well-known international journals.

Poor - represents research of insufficient quality.

However, the evaluation group are free to use another terminology or grade system if it finds it more suitable.

NUTEK appreciates a discussion on priorities of actions, both in terms of financial support and of more structural matters.

Handling and distribution of the report

The report of the evaluation group is presented to NUTEK. It is also openly circulated to all grant holders concerned and, on request, to any other agencies or persons who have expressed an interest in this type of information. (All reports of this kind become, by Swedish law, public documents.) The Swedish scientific community are, however, used to these outspoken international reports.

Remuneration

The members of the evaluation group receive a remuneration according to NUTEK's regulations, US$ 2000. NUTEK will also pay for daily allowances and prepaid tickets, which will be sent to you in due time.

Yours sincerely

Birgitta Palmberger
Head of Department

Nina Österlund

Evaluated projects

146 313-3 Whole tree harvesting effects on forest soil

Effects of whole tree harvesting on long term soil productivity

Project leaders:
Dr Heléne Lundkvist and
Dr Jan Bengtsson
Department of Ecology and Environmental Research
Swedish University of Agricultural Sciences
P. O. Box 7072
S-750 07 Uppsala, SWEDEN
tel no: +46 18 67 24 52

146 314-2 Whole tree utilization - forest yield

Effects of whole tree utilization on forest yield

Project leader:
Professor Björn Elfving
Department of Forest Management
Swedish University of Agricultural Sciences
S-901 83 Umeå, SWEDEN
tel no: +46 90 16 59 13

146 315-3 Nature conservation/Forest energy

Nature consequences of forest energy use

Project leader:
Professor Lars Kardell
Department of Environmental Forestry
Swedish University of Agricultural Sciences
P. O. Box 7078
S-750 07 Uppsala, SWEDEN
tel no: +46 18 67 20 93

146 316-3 Utilizing hardwoods from first thinnings of spruce as fuel wood

Analysis of alternative silvicultural systems for utilizing hardwoods from first thinnings in Norway Spruce stands as fuel wood.

Project leader:
Dr Tord Johansson
Department of Forest Yield Research
Swedish University of Agricultural Sciences
S-770 73 Garpenberg, SWEDEN
tel no: +46 225 221 00

The Evaluation Group

Professor Mike Hornung
Institute of Terrestrial Ecology
Merlewood Research Station
Windermere Road
Grange-over-Sands
Cumbria LA11 6JU
UK

Professor Seppo Kellomäki
Department of Forestry
University of Joensuu,
P.O. Box 111
801 01 Joensuu
FINLAND

Professor Jørgen Bo Larsen
The Royal Veterinary University
Unit of Forestry
Department of Economics and Natural Resources
Thorvaldsvej 57
DK-1871 Fredriksberg C
DENMARK

PROGRAMME FOR THE EVALUATION OF ENVIRONMENTAL IMPACT ON WOOD FUEL HARVESTING

Sunday, November 13th

Arrival of the evaluation group:	Professor Mike Hornung, Institute of Terrestrial Ecology, England
	Professor Seppo Kellomäki, University of Joensuu, Finland
	Professor Jørgen Bo Larsen, The Royal Veterinary University, Denmark

18.00	Get together in the lobby at the Royal Viking Hotel, Stockholm
18.30	General information and background to the evaluation given by Professor Hilmar Holmen and NUTEK representatives Bengt Boström, Göran Friborg and Nina Österlund.
19.30	Dinner

Monday, November 14 th

07.00	Breakfast
08.03	Departure by train from Stockholm C to Uppsala.
08.54	Arrival at **Uppsala.**
09.30	Coffee
10.00	The research group from Garpenberg, Department of Forest Yield Research, gives their presentation of "Analysis of alternative silvicultural systems for utilizing hardwoods from the first thinning in Norway Spruce stands as fuel wood", Dr Tord Johansson and Mr Hans Mård at the locality of Department of Ecology and Environmental Research, Vallvägen 4, Uppsala.
10.30	Questions and discussion.
11.30	Lunch
12.30	"Effects of whole tree harvesting on long term soil productivity", presentation given by Dr Heléne Lundkvist and Dr Jan Bengtsson, Department of Ecology and Environmental Research.

13.30	Questions and discussion.
14.30	Coffee break
15.00	"Nature consequences of forest energy use", presentation given by Prof Lars Kardell, Department of Environmental Research.
15.30-16.30	Questions and discussion.
17.33	Return to Stockholm by train.
18.24	Arrival at Stockholm C.

Tuesday, November 15th

07.15	Transportation to Arlanda by bus (or taxi).
08.15	Departure from Arlanda Airport to Umeå. Breakfast on the plane.
09.15	Arrival at **Umeå** Airport. (Transportation from the airport will be arranged).
09.30	Visit at Department of Silviculture. "Effects of whole tree utilization on forest yield" - brief presentation of research activities.
10.15	Field site visit. - Whole-tree harvesting in final felling (Bo Leijon).
12.30	Lunch
13.30	-Site preparation, biomass harvesting and long term site productivity (Arne Albrektsson). -Whole-tree harvesting in thinning (Gustaf Egnell).
14.30	"Effects of whole-tree utilization on forest yield". Presentation. (Svartberget experimental station)
15.00	Questions and discussion.
16.00	Departure for Umeå.
17.00	Arrival at Umeå airport
17.40	Departure to Stockholm Arlanda.
18.40	Arrival at Stockholm Arlanda Airport. Transportation back to the Royal Viking Hotel in Stockholm.

Wednesday, November 16th

8.00	Writing and compilation of the full draft of the report at the Royal Viking Hotel in Stockholm. Word processing equipment will be provided.
12.00	Lunch
14.00	Visit to the Vasa Museum.

Thursday, November 17th

Writing and compilation of the report.

Friday, November 18th

8.00	Writing and compilation of the report.
11.30	Transportation to NUTEK.
12.00	Lunch at NUTEK.
13.00-15.00	Meeting with NUTEK representatives. Summing up, presentation of the draft evaluation report.

NUTEK Funding of Wood Fuel Harvesting Projects

Fiscal year	*Project number;* Funding SEK/year	*Project number;* Funding SEK/year	*Project number;* Funding SEK/year	*Project number;* Funding SEK/year
	146 313-3 Lundkvist	146 314-2 Leijon	146 315-3 Kardell	146 316-5 Johansson
1988/89	1 239 000	685 000	622 000	1 070 000
1989/90	1 355 000	362 732	57 406	1 087 000
1990/91	1 614 000	*	397 000	885 000
1991/92	1 720 000	799 000	397 000	847 000
1992/93	1 653 000	795 000	347 000	758 000
1993/94	1 707 000	1 000 000	370 000	450 000
1994/95	1 621 000	*	300 000	358 000
Total Funding	**10 909 000**	**3 641 732**	**2 490 406**	**5 455 000**

* The right of disposal of the funds for 1989/90 was prolonged to 30-06-1991 and for 1993/94 it was prolonged to 30-06-1995.

Förteckning över NUTEK Tekniks utvärderingar

Tidigare har NUTEKs peer review-utvärderingar - International Evaluations - publicerats och förtecknats i NUTEKs rapportserie (R-serie).

För att öka tillgängligheten hos NUTEK Tekniks övriga utvärderingar kommer fr.o.m. 1994 även de att publiceras i rapportserien. I utvärderingarna redovisas oberoende bedömares egna uppfattningar om NUTEKs FoU-program, grundade på de undersökningar och analyser som beskrivs i resp. rapport.

A. Förteckning över peer review-utvärderingar (International Evaluations)

Powder metallurgy: B. Aronsson, M. Ashby, M. Glicksman, B. Lux, B.Wilcox. (STU-info 216-1981)

Food technology: Y. Mälkki, J.M. Harper, C.J. King, J. Solms (STU-info 243-1981)

Aeronautics: M.T. Landahl, A.D. Young, P. Hamel, L. Magnusson, J. Carlsson, R.A. Heller (STU-info 263-1981)

Physics and chemistry of surfaces and coatings: J.A. Thornton, M.P. Seah, L.E. Toth (STU-info 264-1981)

Shipbuilding: T.K. Fanneløp, G.K Lea, M.P. Tulin, K. Wieghardt (STU-info 295-1982)

Combustion technology: S.W. Benson, A.C. Eckbreth, P. Hutchinson, T.M. Sloane, F.A. Williams (STU-info 308-1982)

Organic and bioorganic synthesis: G.W. Parshall, B.M. Trost, J. Ugi, O. Vogl (STU-info 313-1983 STU/NFR)

Speach, sound and hearing: N. Caplan, M.H. Goldstein Jr, R.W. Schafer (STU-info 353-1983)

Polymer-based fiber composites: T. Hayashi, J.L. Kardos, R.B. Pipes, D.J. Wilkins (STU-info 381-1983)

Semi-conductor physics: A. Baldereschi, J.C. Bourgoin, G.D. Mahan, R.G. Ulbricht, R.H. Williams, O Goscinski (December 1984 STU/NFR)

Electronic and electrooptic component technology: D. Pederson, R. Mattson, C.L. Tang, S Chandrasekhar, G.T. Wrixon (STU-info 482-1985)

Laser material processing: J. Luxon, W.M. Steen (STU-info 527-1986)

Image processing and analysis: O. Faugeras, T.S. Huang, M. Kunt, A. Rosenfeld, I.T. Young (STU-info 544-1986)

Consumer technology: N.S. Kirk, J. Kronlund, A.M. Small. (STU-info 595-1986)

Carbohydrate chemistry: P. Albersheim, R.U. Lemieux, D. Rees, N. Sharon. (STU-info 607-1987)

Adaptive control of machine tools: F.O. Rasch, Øyvind Bjørke. (STU-info 614-1987)

Adaptive controlled industrial robots: D. Tesar, H. van Brussel. (STU-info 627-1987)

Macromolecular functional chemicals program: B. Krebs, W.H. Pirkle, D.C. Sherrington (STU-info 656-1987)

Separation of biotechnically produced substances: C.K. Colton, M.R. Kula, W. Voser (STU-info 661-1987)

Energy related fluid dynamics: E. Krause, W.C. Reynolds, I.L. Ryhming. (June 15, 1988 STU)

Swedish polymer research and technology: E. Fischer, J.E. Nottke, R. Pethrick, O. Vogl (STU-info 723-1989)

Process intensification in biotechnology: K.Ch.A.M. Luyben, K. Schügerl (STU-info 734-1989)

Activities of the laboratory of applied physics in Linköping: D.A King, C.R. Lowe, T. Hedberg, K. Jegefors (STU-info 760-1989)

Computer science program: J. Allen, J.L. Baer, R. Burstall, Herve´Gallaire, G. Huet, R. Sleep, P. Wegner (STU-info 782-1990)

Digital communication program: R.W. Brodersen, R.G. Gallager, P. Noll (STU-info 785-1990)

Computerised image processing and analyses program: R. Bajcsy, T. Huang, J. Keonderink, R. Plompen, M. Savol, S. Tsuji (STU-info 790-1990)

Catalysis research: G. Ertl, B. Gates, J. Rostrup-Nielsen (April 1990 STEV/STU)

Activities of the Chalmers Liquid Grystal Group, CTH, Sweden: H.J. Coles, G.W. Gray, L.S. Goldberg (STU-info 797-1990)

CAD/CAM Systems with Product Models and AI: W. Eversheim, M. Wozny, N. Suh (STU-info 802-1990)

Chemistry of sulphide mineral processing: A. Bahr, G. Morizot, K. Sandvik (STU-info 814-1990)

Nucleic Acid Synthesis, Structure & Function: C. Altona W.M. Egan, I. Ugi (STU-info 804-1990)

Ore Geology Related to Prospecting: J.P.N. Badham, H. Paunen, I.R. Plimer, D. Rickard, E.F. Stumpf, F.M. Vokes (STU-info 796-1990, NUTEK-info 852-1991)

Micronics: J. Andrade, R. Pethig, D. Thomas, C, Wilkinson (NUTEK-info R 1991:10)

Biocompatible Materials: D.F. Williams, U.M. Gross, A.G. Gristina (NUTEK-info R 1991:32)

Interdisciplinary Consortia in Materials Science and Materials Technology: D.H. Clark, D.T. Clark, F. Koch, K. Spear, G. Edwall, T. Johannesson (NUTEK-info R 1991:26)

Superconductivity Research: M. Beasley, C.W. Chu, V. Emery, C. Heiden, G. Sawatsky, A. Sleight (September 91 NUTEK/NFR)

Adaptive Control of Manufacturing Equipment - Program Report (NUTEK R 1992:47)

Adaptive Control of Manufacturing Equipment - Machine tools: M.F. Vries, H.J.J. Kals, F.O. Rasch (NUTEK T 1992:50, 51) Part I and Part II

Adaptive Control of Manufacturing Equipment - Industrial Robots: H. von Brussel, R.B. Kelley, A. Pugh (NUTEK T 1992:52, 53) Part I and Part II

Downstream Processing - Purification and Recovery of Biotechnically Produced Substances: J. Sjödahl, M. Hoare, M. Harris (NUTEK R 1992:27)

Tribology: D. Dowson, H.S. Cheng, K. Kato (NUTEK R 1992:30)

Conducting Polymers and Polymer Electric Properties - Polymer Chemistry and Polymer Physics: J. Feast, S. Kobayashi, S. Roth, J. Sletbak (NUTEK R 1992:59)

Peptide Technology: K. Bock, G. Jung, B Roques (NUTEK R 1992:6)

Protein Engineering: G. Roberts, W. van Gunsteren, J. A. Wells, G. Winter (NUTEK R 1992:7)

Interdisciplinary Consortia in Materials Science and Materials Technology: T. Anderson, D.H. Clark, D.T. Clark, G. Comsa, F. Koch, H.R. Zeller (NUTEK R 1992:45)

Struktural Ceramics: D. Broussaud, K.H. Jack, D.E. Niesz, E. Seitz (NUTEK R 1993:3)

Computational Methods for Super- and Parallel Computer System R. Glowinski, P. Bjørstad, T. Chan (NUTEK R 1993:7)

Metallkompositer: K. Kleemola, L Arnberg (NUTEK 1993:10)

Language Technology Research Program (HSFR/NUTEK): M. Liberman, V. Zue, W. von Hahn (NUTEK R 1993:19)

Swedish Research in the Field of District Heating: G. Deuster, H. Munser, P. Randløv (NUTEK R 1993:25)

Dynamic Synchronous Transfer Mode: S. Fdida, H Perros, (NUTEK R 1994:20)

Hot Dry Rock: E. Broch, (NUTEK R 1994:57)

International Evaluation of Swedish Research Projects in the Field of System Analysis and Bioenergy: A Frühwald, P Hakkila, B Johnsson, (NUTEK R 1995:2)

International Evaluation of Swedish Research Projects in the Field of Fuel Cells: R Selman, H Wendt, (NUTEK R 1995:8)

Control and Operation of Wastewater Plants – New Methods and New Process Technology (STAMP): J Andrews, L Blackall, G Marais, H Ødegaard, (NUTEK R 1995:11)

International evaluation of the program on Fluid Dynamics: W Rodi, Ch Hirsch, I Rhyming, PL Viollet, (NUTEK R 1995:39).

International Evaluation of Swedish Research Projects on the Environmental Impacts of Wood Fuel Harvesting: M Hornung, S Kellomäki, JB Larser, (NUTEK R 1995:43).

B. Förteckning över övriga utvärderingsrapporter (fr.o.m. 1994)

Tekniska dispersioners struktur och egenskaper: Rolf Brännland och Martin Hellsten - Relevansutvärdering av NUTEKs ramprogram (NUTEK R 1993:27)

Försök med system med resultatmått. Karin Hååg och Torbjörn Winqvist, NUTEK Teknik (NUTEK R 1994:9)

Kommunikationshjälpmedel för handikappade: Håkan Selg, Konsultfirman Fernández & Selg AB, Utvärdering av ett insatsområde - relevans, effektivitet och effekter (NUTEK R 1994:21)

Utvärdering av järnvägsforskning vid KTH. Mats G. Engström, Nordplan och Thomas Edström, ABB Corporate Research. (NUTEK R 1995:29, KFB dnr 94-484-69)

Utvärdering av den industriella relevansen hos NUTEKs strömningstekniska program. Rune Gustafsson och Lars Strömberg. (NUTEK R 1995:40)

C. Övriga utvärderingar innan 1994

I Resultatanalys - Teknisk FoU, rapport inom ramen för NUTEKs fördjupade anslagsframställan för 1993/94-1995/96, ingår en förteckning över samtliga utvärderingar som utförts inom NUTEK Teknik och dess föregångare under perioden 1987- mars 1992.

Sedan den förteckningen skrevs har ytterligare ett antal utvärderingar publicerats:

Teknikutveckling i samverkan mellan högskolan och industrin, Tor Leif Andersson, TELLUS ENERGI AB, 1993. Intervjuer med högskoleforskare och industriföreträdare inom områdena värmepumpar, batterier för elfordon och förbränningsmotorer. BFR, NUTEK och Transportforskningsberedningen.

Gruvteknik 2000. Huvudrapport 1992-10-06. Håkan Selg, konsultfirman Fernandez&Selg AB, 1992. Utvärdering av ett 5-årigt program finansierat gemensamt av STU/NUTEK, gruvföretag och tillverkande industri.

Forskningsprogram privatskogsbruk Utvärderingsresultat, Erkki H. Oksanen, Finn H. Braecke, Juoko Mäkelä, 1991

Utvärdering av Forskningsprogram Privatskogsbruk, Mårten Bendz, Jordbrukstekniska institutet, 1992

Evaluation of the AMT Action Areas, Erik Arnold Technopolis Ltd och John Bessant, Brighton University, 1992. Utvärdering av tre insatsområden inom det verkstadstekniska området: produktdatasystem i verkstadsföretag, datorintegrerad detaljtillverkning samt flexibla monteringssystem,

Uppföljning av PBE-satsningen (Polymera materials bearbetning och egenskaper) Christer Stockman, Independent Professional Consultants AB, 1993-04-26

95-11-06

Böcker och rapporter från NUTEK 1994-1995

Cumulative List of Publications issued by the Swedish National Board for Industrial and Technical Development 1993-1994

Är du intresserad av att teckna ett årsabonnemang på NUTEKs böcker och rapporter?
Skicka då in din intresseanmälan till NUTEK, Informationsenheten, 117 86 Stockholm. Fax 08-19 68 26

NUTEK har publicerat följande utredningar i bokserien (B).

NUTEK has published the following reports from the Booklist (B).

B 1994:1 IEA Bioenergy Annual Report 1993
B 1994:2 IEA WindEnergy Annual Report 1993
B 1994:3 Statsbudgetens regionala fördelning
B 1994:4 Småföretagen – Sveriges framtid?
B 1994:5 Nya grepp om ekonomi, energi och miljö på lokal nivå
B 1994:6 Statistik på räkningen - bättre kontroll för kunden
B 1994:7 Small business in Sweden
B 1994:8 Programmet för effektivare energianvändning. Energianvändningsrådets rapport 1993/94
B 1994:9 Energirapport 1994
B 1994:10 EUs FoU-program
B 1994:11 Hushållsel i småhus

B 1995:1 Infrastruktur för informationssamhället
B 1995:2 IEA Bioenergy Annual Report 1994
B 1995:3 Pengarna och livet - perspektiv på kvinnors företagande
B 1995:4 Statsbudgetens regionala fördelning II
B 1995:5 IEA Alternative Motor Fuels. Annual Report
B 1995:7 Telematics Profile
B 1995:8 Who is who in Telematics?

NUTEK har publicerat följande utredningar i rapportserien (R).

NUTEK has published the following reports from the Reportlist (R).

R 1994:1 Industri- och energirelevanta kompetenscentra i anslutning till universitet och högskolor
R 1994:2 Tyska erfarenheter av EGs forskningsprogram
R 1994:3 Askåterföringssystem. Tekniker och möjligheter
R 1994:4 Perspektiv på aska. En pilotstudie om attityder till spridning av vedaska i skogen.
R 1994:5 Oxygenater i motorbensin
R 1994:6 Affärsetablering i Polen
R 1994:8 Tekniska och ekonomiska förutsättningar för ökad användning och export av limträ
R 1994:9 Försök med system med resultatmått
R 1994:10 Energianvändningen i Sverige - Ett internationellt perspektiv
R 1994:11 Länsstyrelsernas regionala projektverksamhet
R 1994:12 Nya miljöanpassade produkter från förnyelsebara råvaror
R 1994:13 Teknikutvärdering av sticklingskördare

Försäljning sker genom NUTEK Förlag, 117 86 Stockholm. Tel 08-681 92 98. Fax 08-681 92 05.
Orders: NUTEK Förlag, S-117 86 Stockholm. Phone +46 8 681 92 98. Fax +46 8 681 92 05.

R 1994:14 FoU inom IT-området - statistisk översikt
R 1994:15 Trädbränsle -94
R 1994:16 Energigrödor -94
R 1994:17 Avfall -94
R 1994:18 Kol -94
R 1994:19 Intermodal Freight Centres in Europe – A Strategic Analysis
R 1994:20 Evaluation of the Dynamic Synchronous Transfer Mode (DTM) – Report of the International Evaluation Committe
R 1994:21 Kommunikationstekniska hjälpmedel för handikappade – Utvärdering av ett insatsområde
R 1994:22 Rapsolja och rapsoljeprodukter. Miljöpåverkan och potential på bränsle- och drivmedelsmarknaden
R 1994:23 Neuronnät inom medicinsk teknik och informationsbehandling
R 1994:24 Sammanfattande utvärdering av svenska försöksodlingar med Salix 1986–1991
R 1994:25 Gödsling av salixodlingar
R 1994:26 Systemstudier inom energiforskningen - En inventering
R 1994:27 Kultur som utvecklingsfaktor
R 1994:28 Minikraftverk med gengasdriven förbränningsmotor
R 1994:29 The combined generation of heat and power in Great Britain and the Netherlands
R 1994:30 Dimensioner och mönster i industrins förnyelse och tillväxt
R 1994:31 Konjunkturbilden för mindre och medelstora företag
R 1994:32 EUs gemensamma näringspolitik
R 1994:33 Kartläggning av räkningsinformation samt genomförande av energieffektiviseringsåtgärder. Utvärderingsrapport 1 – Bättre energiräkningar
R 1994:34 Processutvärdering. Utvärderingsrapport 2 – Bättre energiräkningar
R 1994:35 Kvalitativ studie. Utvärderingsrapport 3 – Bättre energiräkningar
R 1994:36 Företagsekonomisk utvärdering. Utvärderingsrapport 4 – Bättre energiräkningar
R 1994:37 Undersökning bland abonnenter. Utvärderingsrapport 5 – Bättre energiräkningar
R 1994:38 Utvärdering av energispareffekter. Utvärderingsrapport 6 – Bättre energiräkningar
R 1994:39 Ramprogram Askåterföring
R 1994:40 R & D in Swedish Multinational Corporations
R 1994:42 Olja och gas -94
R 1994:43 Energiteknikfonden. En analys av satsningar och bidrag till utveckling ur ett marknadsperspektiv
R 1994:44 Marknadsförutsättningar för biobränslekraftvärme och vindkraft
R 1994:45 Att påverka marknader effektivt. – en effektkedjeanalys av NUTEKs satsningar på högfrekvensdon
R 1994:46 Detaljerad sammanställning av vissa belysningsprojekt
R 1994:47 Företagsledarnas syn på näringsklimatet
R 1994:48 Utvärdering av styrmedel och stöd för begränsning av koldioxidutsläpp i Sverige
R 1994:49 Energy Report – Summary and conclusions
R 1994:50 Informationsteknologi (IT). En översiktlig regional redovisning
R 1994:51 Erfarenheter av branschprogrammen Trä och Teko
R 1994:52 Inverkan av kalkning och askåterföring på utflödet av kvicksilver från skogsmark – en teoretisk studie
R 1994:53 Soil Biological Aspects of Short-Rotation Forestry
R 1994:54 Hur kan elförbrukningen i svenska hushåll och lokaler påverkas?
R 1994:55 Våras det för rörflen?
R 1994:56 Varv och underleverantörer
R 1994:57 Hot Dry Rock
R 1994:59 1994 års rapport om den regionala utvecklingen i Sverige
R 1994:60 Motorgasdrivna bussar i Sundsvall
R 1994:61 Aviation and the Environment
R 1994:62 Fossila och biobaserade motoralkoholer

Försäljning sker genom NUTEK Förlag, 117 86 Stockholm. Tel 08-681 92 98. Fax 08-681 92 05.
Orders: NUTEK Förlag, S-117 86 Stockholm. Phone +46 8 681 92 98. Fax +46 8 681 92 05.

R 1994:63 Länsstyrelsernas projektverksamhet
R 1994:64 Klimatrapporten
R 1994:65 Regionalt program- och strategiarbete
R 1994:66 Utvärdering av den arbetsmarknadspolitiska åtgärden Arbetslivsutveckling, ALU
R 1994:67 Arbetslösa civilingenjörer – en outnyttjad resurs för småföretagen?
R 1994:68 Nätkostnader i överföring och distribution av el
R 1994:69 Miljösamarbete i Baltikum
R 1994:70 Effective market influence
R 1994:71 Peptidteknologins tillämpning

R 1995:1 Biogas som drivmedel för fordon
R 1995:2 International Evaluation of Swedish Research Projects in the Field of System Analysis and Bioenergy
R 1995:3 Kan man samtala via bilder?
R 1995:4 Elbilar i kommersiell användning – Startprojektet, Göteborg
R 1995:5 BoTiS – Biologi och Teknik i Samverkan
R 1995:6 Flottförsök med 32 etanolbussar vid AB Storstockholms Lokaltrafik
R 1995:7 Regionalpolitiskt finansiellt stöd. Budgetåret 1993/94
R 1995:8 International Evaluation of Swedish Research Projects in the Field of Fuel Cells
R 1995:9 Concept study of a heavy-duty bus engine operated on ethanol
R 1995:10 Lilith-projektet – en utvärdering
R 1995:11 Control and Operation of Wastewater Plants – New Methods and New Process Technology (STAMP)
R 1995:12 Klusteranalys och näringspolitik
R 1995:13 System study – Techno/Economical Reviews of a Number of Process Combinations of Ethanol Processes and other Relevant Industrial Processes
R 1995:14 Arbetslösa marknadsförare – en utvecklingsmöjlighet för småföretag?
R 1995:15 Att stimulera nyföretagandet
R 1995:16 Technology procurement as a policy instrument
R 1995:17 En jämförelse av ventilation i nya och gamla kontor
R 1995:18 Innovative Activities in Swedish Firms
R 1995:19 Innovationsforskare i Sverige
R 1995:21 Analysis of the Swedish Participation in Community RTD
R 1995:22 Evaluation and Prospects for NUTEK in the Swedish RTI Programme
R 1995.23 Biogasdrivna bussar i Linköping
R 1995:24 Konjunkturbilden för företag med 1–19 anställda
R 1995:25 Factors for Success in European National Systems for Support to Technology Based Enterprises
R 1995:26 Evaluation of the Research Programme "Ore Geology related to Prospecting"
R 1995:27 Stöd och information till teknikbaserat företagande – Vad kan vi lära av andra?
R 1995:28 Förädlade trädbränslen 1995
R 1995:29 Utvärdering av järnvägsforskning vid KTH
R 1995:30 Domestic electricity in detached houses
R 1995:31 Kol -95
R 1995:32 Avregleringarnas regionala effekter. En litteraturstudie
R 1995:33 Nya fönster uppåt väggarna – en utvärdering av attityder till energieffektiva fönster
R 1995:34 Det våras för kansliet – en samlad bild av utvärderingarna gjorda första halvåret 1995
R 1995:35 Tillverkarnas tävling trimmade tvättstugorna
R 1995:36 Salix - Långsiktig produktionsförmåga under storskalig etablering
R 1995:37 Avreglering av elmarknaden
R 1995:38 Teletjänster och IT-användning i Sverige
R 1995:39 International evaluation of the program on Fluid Dynamics
R 1995:40 Utvärdering av den industriella relevansen hos NUTEKs strömningstekniska program
R 1995:41 Ethers in Gasoline

Försäljning sker genom NUTEK Förlag, 117 86 Stockholm. Tel 08-681 92 98. Fax 08-681 92 05.
Orders: NUTEK Förlag, S-117 86 Stockholm. Phone +46 8 681 92 98. Fax +46 8 681 92 05.

R 1995:43 International Evaluation of Swedish Research Projects on the Environmental Impacts of Wood Fuel Harvesting

Försäljning sker genom NUTEK Förlag, 117 86 Stockholm. Tel 08-681 92 98. Fax 08-681 92 05.
Orders: NUTEK Förlag, S-117 86 Stockholm. Phone +46 8 681 92 98. Fax +46 8 681 92 05.

Upplaga: 300 ex
Produktion: NUTEK Teknik
Stockholm 1995

ISSN 1102-2574
ISRN NUTEK - R -- 95/43 -- SE
NUTEK R 1995:43

NUTEK

B E S T Ä L L N I N G A R

NUTEK Förlag
Trycksaksexpeditionen
117 86 Stockholm

ORDERTEL: 08-681 92 98
ORDERFAX: 08-681 92 05

ISSN 1102-2574