

III.2 Economic analyses of the future development of organic farming Effects at the field, farm, sector and macroeconomic levels

Acronym:

ECON-ORG

Date:

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1. Summary

The objective of this research project is to analyse the future development of organic farming in Denmark from the field, farm, sector and macroeconomic perspectives. Emphasis will be placed on the economic impacts of a continued expansion of organic farming in Denmark taking into account the adjustment problems of converting conventional farming into organic farming. Part of the research will also be devoted to analysing the regional effects, the impact on various environmental indicators of organic farming as well as the economic effects of policy initiatives in general (i.e. changes in agricultural and environmental policies).

The research project is characterised by co-ordinated efforts from the field level to the farm, sector and macroeconomic levels. At the field and farm levels the project will focus on the specification of labour and machinery systems in organic farming. Furthermore, the implications for total production costs and cost structures for different farm types will be determined. Given these and existing data for cost structures in conventional and organic farming, existing farm, sector and macroeconomic models will be adjusted and extended to incorporate the information obtained through this research project. Key words for the research efforts are the analyses of barriers to entry, the effects of uncertainty with respect to future markets and prices for organic products, impacts of different policy initiatives as well as the dynamic processes of converting Danish conventional farming into organic farming.

A core activity of the project will be to undertake a number of illustrative scenarios describing the economic effects at the farm, sector and macroeconomic levels. The scenarios will be co-ordinated across all work packages. The scenarios will include both the construction of a baseline scenario describing possible perspectives for the future expansion of organic farming in Denmark as well as a number of policy, regulatory and technology scenarios.

The results of the research project will illustrate the impacts of different designs of agricultural and environmental policies on the agricultural sector in general and on organic farming in particular. Furthermore, the results from the field and farm level analyses can be used to support farmers in converting to organic farming and to develop organic production systems.

Finally, the results from the research project will be made available to the public through the SJFI web site as well as through the publication of working papers, articles and research reports. Moreover, the research group is planning to arrange both a mid-term workshop and a final policy workshop with the objective of discussing methodology, data and policy implications.

2. Research group

Two research institutes are involved in this research project, namely the Danish Institute of Agricultural Science, Department of Agricultural Engineering (DIAS-DAE) and the Danish Institute of Agricultural and Fisheries Economics (SJFI), Agricultural Policies Research Division (Policy) and Farm Management and Production Systems Division (Farm).

The two institutes have successfully collaborated on earlier research projects, demonstrating good capabilities for co-operating. Efforts will also be devoted to taking on board research results obtained from other parts of the overall research program of organic farming, such as the future demand for organic products in Denmark and abroad.

The research team consists of:

Søren E. Frandsen, Research Director, SJFI-Policy (Project Co-ordinator)

Brian Jacobsen, Senior Researcher, SJFI-Farm

Lars-Bo Jacobsen, Researcher, SJFI-Policy

Jørgen D. Jensen, Senior Researcher, SJFI-Policy

Paul Kledal, Research Assistant, SJFI-Farm

Villy Nielsen, Senior Researcher, DIAS-DAE

Claus G. Sørensen, Senior Researcher, DIAS-DAE

Niels Tvedegaard, Research Assistant, SJFI-Farm

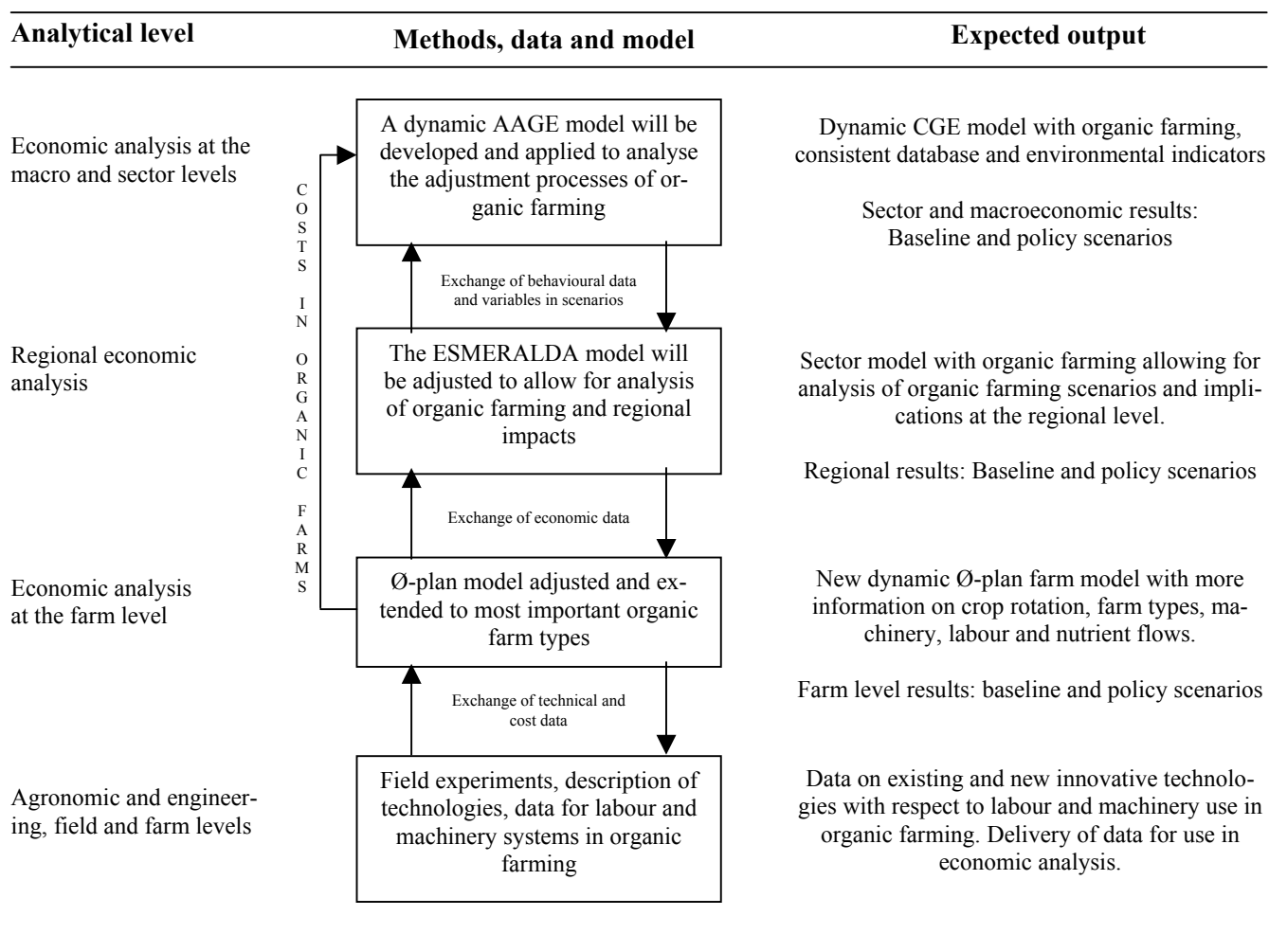
Jens Erik Ørum, Researcher, SJFI-Farm

3. Introduction and overview

Previous research in organic farming and the research undertaken under the auspices of the so-called Pesticide Committee (Bichel-udvalget) have demonstrated the need for combining and strengthening agronomic and engineering insights with economic expertise allowing for a systematic approach to establishing a consistent analytical framework. The present research proposal draws on these earlier experiences and hence an overall research project is suggested in which both agronomic experts and micro and macro economic experts participate and co-ordinate their efforts. Furthermore, the project proposes to extend and improve already established databases and models at the farm, sector and macroeconomic levels. In this way, the project builds upon the expertise already established at the two research institutions, cf. for example the research projects ‘Agriculture and Rural Districts: Economy and Development’, ‘Sustainable Strategies in Agriculture’ and ‘The Potential of Organic Farming in a Sustainable Development’.

Figure 1 illustrates the overall structure of the proposed research project. The research project can be divided into four analytical levels, ranging from research at the field level through the farm, regional and sector and macroeconomic levels. The project represents a unique integrated approach in the sense that the efforts are closely co-ordinated across the four analytical levels while at the same time the applied analytical methods differ reflecting their appropriateness for analysing the particular questions at hand at the different levels.

Figure 1. Overview of the research project



4. State of the art

Previous research projects have identified a number of areas in which new and intensified efforts are needed in order to analyse and evaluate the future development of organic farming in Denmark, namely

- to extend and improve the data on labour and machinery demand in organic farming (improving the field data),
- to extend and improve the farm, sector and macroeconomic analytical framework, including extending the coverage to all major organic farm types and to enable an improved co-ordination with the agronomic and engineering knowledge (improving the technological, economic and environmental data),
- to develop the theoretical and analytical methodology to take into account the dynamic processes of converting Danish Agriculture into organic farming
- to analyse the potential for extending organic farming practices in given regions or areas of Denmark

Labour and Machinery demand.

Studies of the labour and machinery usage in a transition from conventional to organic farming have assumed a significant increase of the labour demand (e.g. Macrae (1990), Dubgaard, (1994), Klemola (1997)). The increase in labour requirement has been assessed as ranging from 15 to 70% in plant production due to more rotational crops, increased mechanical weed control, increased crop supervision, etc. However, previous research into organic farming has in most cases been based on uncertain and insufficient data on labour and machinery demand.

The problem, is that the data material has not been able to uniquely describe the labour requirement related to factors like farm type, type of production, level of mechanisation, etc. Therefore, existing modelling approaches on labour demand and machinery input, used for conventional farms, has not been used on organic farming systems (Nielsen & Sørensen, 1993). Also, the analysis has assumed that it is possible to procure the necessary labour force, both with respect to quality and quantity (e.g. manual weed control). However, this may not always be the case, especially if organic plant production is gaining more ground.

Organic farming offers significant challenges to the farm management function as the result from the different cropping operations depends on the biological conditions. Thus, more time is being used for supervision of the crops compared with conventional farming, where the possible insufficient supervision may be compensated by applying pesticides or fertilisers. It is essential to determine the amount of time being used to monitor the status of the crops and probable future development. Especially the greater inherent variability in organic production will provide for an increased labour requirement as related to planning and controlling work operations. Additional, an effective management of the work operations requires a detailed knowledge of the capacity of the labour and machinery available.

With respect to machinery input, detailed analyses of actual machinery systems and actual machinery costs have been scarce. Hence, the assumptions in the economic analyses have been that contractors are able to carry out all machine operations on the individual farm (Folkman & Poulsen, 1998). This assumption may, however, be compromised, as it is not certain that contractors have the specialised machinery needed in organic farming. Furthermore, the optimal time for some operation especially in organic production is very short why timeliness is a very important factor.

Currently, new methods aimed at weed control in organic farming is being developed, but in general it is difficult to assess the consequences of applying new technologies (e.g. integrated application of automatic row guidance) when no analyses of the present technology are available. Often the new technology will indicate more capital input but lower labour demand.

Summarising on the data for demand for labour and capital, the current knowledge only offers a diffuse image of the real demands and consequences concerning labour and machinery input. Consequently, there is a need for a systematic analysis of the technical operational consequences and subsequent prognosis of the labour requirement, capacity, and labour profiles for specific organic production systems, including the evaluation of innovative cropping and mechanisation systems. The latter is important, as the continuing development of organic farming systems will probably imply an increased application of innovative types of machinery and systems, which are specifically adapted to the principles of organic farming.

Economic data and modelling. Focusing on the economics and organic farming, the Danish Institute of Agricultural and Fisheries Economics has for a number of years carried out research with respect to income in organic farming (Dubgaard and Sørensen, 1988; Dubgaard et al., 1990). Since 1998 a yearly income statistic has been published (SJFI, 1998). The statistics show e.g. that organic dairy farming has been more profitable than conventional dairy farming. These results have also been used in analyses of the income in organic farming in different countries in Europe (Offermann and Nieberg, 1999).

Research projects at *the farm level* have also looked at the cost structure of a range of different organic productions under different marked conditions and possible regulations (Folkman and Poulsen, 1998). Current

microeconomic research involves the study of the economic consequences of changing from conventional to organic farming at the farm level. A dynamic model called Ø-plan has been developed to simulate the expected economic consequences over the first six years of the conversion period for different farm types. The economic performance is measured as the net profit where all input factors are evaluated using the opportunity cost principles. The economic simulations are grounded on rather detailed technical-biological data for crop rotations and animal production, whereas the machinery costs are based on contractor prices.

Furthermore, the existing regulations and support regimes in organic farming are taken into account in the simulations. Due to the complex production structure and the intertemporal dynamics in organic farming no overall optimization has so far been included in the model. Instead the current model framework consists of several modules among which some are sub-optimized, e.g. the purchase of variable inputs, the sale of organic produced products and the economic optimal application of manure to competing crops. Tvedegaard (1999) and Tvedegaard (2000) contain results of using the Ø-plan model on crop and pig farms, respectively. Presently the model development is extended to include poultry production.

There is a well-founded knowledge of the variable costs involved in organic farming for most crops. However, the research on the cost structure of different machinery systems and technologies is limited. Furthermore, labour on organic farms has been treated as a uniform input, with less emphasis on labour skills and availability.

The organic production for some crops is limited, why Denmark has a large import of these crops. Crops like grass for seed, wheat for baking, protein crops for feed and sugar beet need to be analysed more closely as they seem not to a chosen option for organic farmers in Denmark today. Here new technologies will decrease the use of labour and perhaps lower the production costs, making it more profitable for farmers to grow these crops.

At the sector and regional level statistics seem to indicate that the adaptation of organic agriculture is very different in different parts of Denmark. Nevertheless, only limited research has been devoted to these aspects. Within one research projects (Agriculture and Rural Districts: Economy and Development) the development of a econometric model of the Danish agricultural sector (the ESMERALDA model) is undertaken. The main data source is SJFI's farm account statistics, including (although a relative minor number of) organic farmers. One of the strengths of the approach is the econometric description of the behaviour of Danish (conventional) farmers and the flexibility of the approach to take into account specific farm structures and farm types. The approach allows a relative flexible aggregation at the sector and regional level on the basis of individual behavioural parameters. However, the model has not yet been developed or specifically used for analysing the behaviour and development of organic farming in different regions of Denmark.

At the macroeconomic level an earlier version of the general equilibrium model for the Danish Economy - the so-called AAGE model - was used when the Pesticide Committee analysed the macroeconomic costs of converting Danish agriculture into organic farming. However, that model was not very well developed or suited for analysing the effects of organic farming, cf. Jacobsen and Frandsen (1999). Therefore the same researchers within a current research project ('The Potential of Organic Farming in a Sustainable Development') is developing a static version of a general equilibrium model of the Danish economy where special attention is given to the representation of organic farming. In particular a corresponding database is being developed, including both conventional and organic farming across a number of main agricultural products thereby allowing for the competition between conventional and organic farmers to be analysed under given exogenous assumptions and scenarios. As mentioned above, that version of the general equilibrium model and database is static. The model is therefore not capable of analysing important dynamic processes of converting part of the agricultural sector into organic practices, i.e. the importance of adjustment costs, entry barriers, uncertainty related to technological possibilities and future markets and prices for organic products.

Finally, a number of recent research projects (e.g. AMOR 4) are devoting time and efforts to collecting and adjusting data for environmental indicators (i.e. in the form of input usage of for example manure and differ-

ent types of pesticides). These data and research results have, however, not yet been applied in the context of converting conventional farming into organic farming and the possible positive derived environmental effects from such a conversion. These projects will be finalised at the end of year 2000.

4. Objectives and expected achievements

The objective of this research project is to analyse the future development of organic farming in Denmark from the field, farm, sector and macroeconomic perspectives. Emphasis will be placed on the economic impacts of a continued expansion of organic farming in Denmark taking into account the adjustment problems of converting conventional farming into organic farming. Part of the research will also be devoted to analysing the regional effects, the impact on various environmental indicators of organic farming as well as the economic effects of policy initiatives in general (i.e. changes in agricultural and environmental policies).

The major achievements will be:

- **Field and farm levels:** A description of the labour and machinery demand and costs involved in different organic lines of production dependent on different technological assumptions (existing and new innovative technologies).
- **Field and farm levels:** An analysis of the cost, direct energy use and impacts on environmental indicators of different organic production systems (existing and new innovative technologies).
- **Farm level:** Development of a farm model (Ø-plan) covering the most important farm types.
- **Sector and regional levels:** Adjustment of a sector econometric model ESMERALDA to describe and analyse organic farming at the regional level.
- **Sector and macroeconomic levels:** Development of a dynamic general equilibrium model for the Danish economy with organic farming included.
- **All levels:** Establishment of an overall consistent model structure – where consistency is established from the field to the farm, sector and macroeconomic level. Given the model structure the research team will be able - with relative short notice – to analyse the economic effects and impacts on environmental indicators of new policy initiatives.
- **All levels:** Construction of a consistent baseline scenario illustrating future developments of organic farming in Denmark dependent upon a number of different supply, demand and policy assumptions.
- **All levels:** Economic analysis of a large range of different agricultural, environmental, regulatory and technology scenarios of which a number of scenarios will be co-ordinated across all five work packages.

5. Description of workpackages

Table 1: Workpackage list

Work-package No	Workpackage title	Responsible participant	Budget, Mio. DKr.	Start	End	Deliverable No
1	Labour and machinery systems in organic farming	DIAS-DAE	1,400	1.10.2000	1.10.2003	1,2,3
2	Organic farming at the farm level – A study of the conversion process.	SJFI-Farm	1,860	1.01.2001	1.10.2003	4,5,7,8
3	Economic Analysis of organic farming at the regional level	SJFI-Policy	0,500	1.11.2001	1.07.2003	9,10
4	Development of a dynamic general equilibrium model with organic farming	SJFI-Policy	0,935	1.01.2001	1.06.2002	11,12
5	Economic analysis of organic farming at the sector and macroeconomic level	SJFI-Policy	0,935	1.06.2002	1.01.2004	13,15

6. Implementation and time schedule

WP1: Labour and machinery systems in organic farming

Work package number:	1
Start date or starting event:	1/10/2000
Responsible person:	Claus G. Sørensen
Contributing persons:	Villy Nielsen
Person-months:	29,5 (1,40 mill DKr.)

Objectives

1. Identify and characterise innovative and selected existing labour methods and technologies related to organic farming systems
2. Adapt labour and machinery studies to organic farming and specifically extend them to include normally non-quantified tasks (e.g. management efforts, on-farm processing)
3. Develop, adapt and apply an integrated approach involving labour budgeting, labour profiles, machinery capability, etc. to organic farming systems
4. Incorporate complete operational labour and machinery data into models of specific organic production systems, including an evaluation and optimisation of all work operations
5. Provide for the use of labour and machinery data and models as part of economic scenario analyses describing the development of organic farming at farm level

Description of work

The work will start with an assessment of existing data on machinery and labour used for existing technologies, which can be adopted in organic farming. The research will then focus on new technologies and work methods, which e.g. are in the process of being tested as part of other research initiatives and which are therefore only used on few farms. Existing databases concerning labour and machinery input contain data covering current work methods (e.g. traditional ploughing, direct seeding), which are used in conventional farming will be up-dated with data from organic farming (Nielsen & Sørensen, 1993). The database will be extended with specific work methods only used in organic farming. That will involve operations like, for example, non-chemical weed control, manual work operations in row crops, post-harvest processing, grazing systems, out-door pig systems as well as more general management tasks like planning and control.

The applied methodology will involve the work-study as the tool for a systematic, objective and critical analysis of the factors that control the operational efficiency (in terms of labour demand, machine capacity, etc.) of a specified activity. The study will be based on a method where each part of the entire machinery operation are analysed. These part operations are selected in such a way that the factors, which will significantly effect the labour demand of a specified activity, can be identified. The measured data for different part operations are organised in databases containing the “bricks” for aggregating labour demand for any specified activity on the farm.

Based on the work-studies the labour demand may be estimated for an operation, for a specific production, or for the whole farm given technical-biological prerequisites like the type of machinery system, machinery size, field size, and crop yield, all of which identify system related differences. The model solution provides for the planning and evaluation of models representing different production systems. Thus, labour and machinery data/models may be used in two ways: 1) in a diagnostic way to determine the labour use based on the current labour and machinery system, and 2) in a prognostic way as a model, which gives the labour use for different machinery systems based on a chosen crop rotation.

The primary analysis and diagnosis of selected technologies and work methods will generate the preliminary data needed for analyses of case farms. Following a biological specification, model farms representing different organic production systems are identified (e.g. plant production, cattle production, pig production, mixed

production, vegetable production). This identification of model farms will be designed in close co-operation with WP2. The model farms may be designed on the basis of information from existing organic pilot farms, data from research on rotational crops (e.g. Aksegaard et al., 1997) or results from model calculations (Folkman & Poulsen, 1998). In connection with the identification of model farms a preliminary optimisation/harmonisation of the machinery complement will be included (Søgaard & Sørensen, 1999). Also, the use of machine pools between farmers, as a way of reducing machinery costs, will be examined.

The identified model farms will be analysed as regards labour demand, labour profile, and machinery capability. The assessments of the model results will include an assessment of innovative technologies as compared to existing technologies. Subsequently, the results will be evaluated against selected pilot-farms.

Deliverables

D1: Paper on existing labour and machinery data on organic farming tasks and determination of comparability with data requirements for economic scenario analysis and need for future research.

D2: Paper on new innovative technologies and work methods

D3: Whole-farm analysis of labour and machinery demand, labour budgets and labour profiles for selected farm types with a specified collection of work operations (DIAS report).

It is the intention to publish an international article on the findings.

Milestones

1. Existing labour and machinery data related to organic production practices identified
2. Completion of plan for data acquisition on labour demand, and machinery capacities
3. Selected technologies and work methods
4. Completion of collection of data labour demand, and machinery capacities for selected technologies and work methods
5. Publication of preliminary results on labour and machinery demand at the crop level
6. Selection and design of model farms with adapted technologies
7. Completion of analysis and modelling of labour and machinery demand, labour budgets and labour profiles for selected farm types
8. Labour and machinery data and models delivered for economic scenario analysis
9. Publication on integrated labour and machinery data and models

WP2: Organic farming at the farm level – A study of the conversion process

Workpackage number:	2
Start date or starting event:	1.1.2001
Responsible person:	Brian H. Jacobsen
Contributing persons:	Paul Kledal, Niels Tvedegaard, Jens Erik Ørum
Person-months:	36 (1,860 mill. DKr.)

Objectives

1. Cost analyses on innovative technologies for use in Ø-plan based on findings from WP1.
2. Improve Ø-plan by incorporating more crop rotations and farm types.
3. Improve Ø-plan in order to include nutrient flows (N, P and K-surplus)
4. Analyse the impact of changes in regulations, market prices, technologies and management on income, nutrient surplus and direct energy use on a range of different farm types.
5. Give ideas on how new technologies can be implemented at the farm level and the consequences for production costs.
6. Modify and adapt data in co-operation with WP3 and WP4 to be used at the regional and sector level.

Description of work

Based on the findings in WP1 an assessment of the costs of labour and machinery use will be carried out. The calculation will include crop rotations with crops, which are currently not cropped organically. These crops are grasses for seed, wheat for baking, protein crops for feed, sugar beet, etc. The focus will be on new technologies for the fieldwork, but also updated data for machinery and labour use in the animal production will be included. The machinery and labour costs of the different technologies will then be included in the Ø-plan model.

The data from WP1 will firstly cover existing technologies, then preliminary data for innovative technologies and then the final data. This procedure will allow the model framework to be established relatively early in the process. The same principle will be used for the data transmission from WP2 to WP3 and WP4.

Ø-plan will be extended to cover more crops and more production in order to be able to deal with most crops and farm types. This will also allow the model to be used in assessments of subsidies for organic farms in the first years of production as Ø-plan is a dynamic model, describing the economic result over a 6-year period. The model will also be used to give a detailed account of the effect of different conversion strategies.

A further development of the Ø-plan model will make it possible to calculate the environmental effects (e.g. N, P and K-surplus) for different crop rotations. Estimates on N-leaching, NH₃-emission etc. for different systems will be based on findings from projects focusing on the nutrient flows on organic farms carried out at e.g. The Danish Institute of Agricultural Sciences. The direct energy use (fuel and electricity) will also be calculated.

The selected model farms will be established in co-operation with WP1 in order to ensure that the farms represent the most typical farm types in organic farming.

The model will then be verified at the farm level based on findings from the farm statistics and the detailed registrations from selected “study”-farms. The results will also be compared with the findings from the so – called Pesticide Committee, which also looked at organic farming (Ørum, 1999).

The Ø-plan will then be used to look at economic and environmental effects of changes :

- Price changes
- New technologies

- Changes in regulation for organic farms
- Management on a range of farm types.

The work will give suggestions as to whether organic products, that are not widely adopted in Denmark today, will be produced on a larger scale. The analysis will try to look at whether the new production systems will lead to a reduction in production costs making the products more desirable for more consumers. The project therefore gives ideas as to where production costs can be lowered and how costly it will be for farmers to adopt the new technology. These recommendations can then be used in the advisory service and by organic farmers.

Finally, the data will in co-operation with WP3 and WP4 be prepared for sector analyses. To the extent there are no statistical data to determine the elasticities on all organic farm types, the results from the model farms will be used.

In order to ensure co-operation between the technical and economic side there will be a close co-operation between the participant in WP1 and WP2. There will be group meetings in order to ensure close co-ordination. The co-ordination to WP3 and WP4 is easier as it is within the same institution.

Deliverables

- D4: An SJFI-paper on the machinery and labour costs of specific systems.
- D5: An SJFI-paper as documentation for the new Ø-plan with more crop rotations, farm types, machinery, labour and nutrient surplus.
- D7: An SJFI-paper on the data to be used in the sector analysis
- D8: An SJFI-report on the results from different farms and scenarios

It is the intention to publish an international article on the findings.

Milestones

1. Labour and machinery data from WP1 are received and adjusted to be used in Ø-plan
2. New crop rotations and farm types are included in Ø-plan
3. Nutrient surpluses are included in Ø-plan
4. Machinery and labour data for new technologies are included in Ø-plan
5. Verification of the whole farm results in relation to study farms
6. Analyse the impact of changes in regulations, marked prices, technologies and management on income, nutrient flow and energy use on a range of different farm types are finished.
7. Data for sector analysis are prepared
8. Report on effect of different scenarios on a range of model farms

WP3: Economic Analysis of organic farming at the regional level

Workpackage number:	3
Start date or starting event:	1.11.2001
Responsible person:	Jørgen D. Jensen
Contributing persons:	Research Assistant
Person-months:	10 (0,500 mill. DKr.)

Objectives

1. Develop a quantitative modelling framework for analysing regional economic aspects of organic farming
2. Investigate the economic potential for organic farming at the regional level
3. Investigate the economic consequences for the agricultural sector of enhancing organic farming in specific regions

Description of work

As mentioned above, the methodological basis for the regional economic analyses of organic farming is an established econometric sector model – ESMERALDA (see e.g. Jensen, 1996, Kristensen & Jensen, 1999). The current model version simulates economic behaviour on approximately 2000 different conventional farms, which are subsequently aggregated to the relevant level of aggregation (e.g. national sector level or regional level). However, organic farming is only sparsely represented in the current model version.

The project includes five main tasks:

1. Establishing a data base for organic farming in Denmark
2. Establishing behavioural parameters for the organic farming sector.
3. Developing procedures for aggregating organic and conventional farms to the regional level
4. Model analysis of the economic potentials for organic farming in different regions of Denmark
5. Analysing regional economic consequences of enhancing organic farming in specific regions of Denmark.

1. Establishing a data base for organic farming in Denmark

First step of the project will be to establish a database representing the population of organic farms in Denmark, which will be based on the agricultural account statistics database for organic farms provided by SJFI. The database will include information on farm size, land use, livestock holds, agricultural output and input use, costs, revenues, incomes etc. for approximately 175 anonymous individual organic farms supplemented with Ø-plan simulations for organic farm types not represented in the statistical data material. Such a database is considered to be sufficiently large to adequately represent the diversities within the organic agricultural sector.

2. Establishing behavioural parameters for the organic farming sector

In order to assess the production behaviour on organic farms under different price conditions etc. there is a need for behavioural parameters representing organic farms. As the available data material is too limited to enable econometric estimations of such behavioural parameters for Danish organic farms, other avenues must be followed, including international surveys, adaption of normatively based farm level behavioural parameters (cf. work package 2), as well as adaption of econometrically estimated behavioural parameters from conventional farms.

3. Developing procedures for aggregating organic and conventional farms to the regional level

By attaching a set of aggregation factors to the individual farms in ESMERALDA, the farm level results can

be aggregated to the relevant (national or regional) sector level. Whereas procedures for generating aggregation factors for conventional farms have been established, these procedures must be expanded to include organic farms, with particular emphasis on the regional level. In addition, flexibility in the aggregation procedure must be ensured in order to take into account the effects of different scenarios concerning organic agriculture.

4. Model analysis of the economic potentials for organic farming in different regions of Denmark

Having established a regional description of the entire agricultural sector, including conventional as well as organic farms, the economic potentials for expanding the organic sector in various regions of Denmark can be analysed. The economic potentials of organic versus conventional farming reflect the relative profitability of the different farm and production types in different regions, and ESMERALDA can be used for analysing these aspects in the considered scenarios. Methodologically, this sub-project is based on the provided description of economic behaviour on organic farms, as compared with that on conventional farms (cf. tasks 1 and 2). Among other issues, the analyses will point to the regions with the largest economic potential for expansion of organic farming under various conditions, as well as contribute to the assessment of economic barriers to expansion of organic farming in different regions.

5. Analysing regional economic consequences of enhancing organic farming in specific regions of Denmark.

Scenarios for expanding organic agriculture in certain regions of Denmark will be analysed by means of the established model framework. Expansion of organic farming will take place at the cost of conventional farming, and hence the economic consequences reflect the economic benefits from an increased organic production as well as the loss of conventional production in the considered regions. This is analysed by imposing changes on the aggregation factors (cf. task 3), thus attaching larger weights to organic farms and lower weights to conventional farms in the calculation of regional totals. The analysis will point at the economic consequences of large-scale conversions to organic farming in different regions of Denmark.

Deliverables

D9: An SJFI-working paper on the development of ESMERALDA to allow for analysis of organic farming (tasks 1-3)

D10: An SJFI-report on baseline results and a selected number of policy scenarios (regional focus) (task 4-5)

It is the intention to publish an international article on the findings.

Milestones

1. Study of the representation of organic farms in the ESMERALDA database
2. Determination of behavioural parameters for organic farms
3. Representation of organic farms on a regional basis (aggregation)
4. Linking of environmental indicators to organic farms
5. Economic potentials for organic farming in different regions of Denmark
6. Undertaken policy scenarios.
7. Report on results found.

WP4: Development of a dynamic general equilibrium model with organic farming

Work package number:	4
Start date or starting event:	1.1.2001
Responsible person:	Lars-Bo Jacobsen
Contributing persons:	Søren E. Frandsen, Research assistant.
Person-months:	19 (0,935 mill. DKr.)

Objectives

1. Development of a dynamic modelling framework, which allows for quantitative assessment of the development of organic farming at the sector and macroeconomic level.
2. Development of a theoretical microeconomic foundation for analysing the potential development of organic farming in a dynamic context. Focus will be on a) uncertainty with respect to the future markets for organic products, b) Uncertainty with respect to the production potential in organic farming, c) Barriers to entry in the organic farming industry, d) Adjustment costs associated with entry to organic farming (paying for sunk cost).
3. Implementation of the theoretical foundation into a quantitative economic model. The implementation ensures the ability to calculate illustrative scenarios of various policy targets of certain aspects with respect to organic farming in a dynamic context.
4. Implementation of environmental indicators in the model framework.

Description of work

The line of work includes the following:

1. Choice of theoretical structure and identifying need for data.
2. Implementation of the theoretical structure, data obtained from work package 2 and 3 and environmental indicators into the applied model and construction of consistent data.

Choice of theoretical structure and identifying need for data.

Development of a theoretical framework that takes into account important determinants behind a farmer's choice between producing organic or conventional products. These include the uncertainty in the development of market possibilities for organic product.

The timing between the decisions to produce to the organic market and to actual organic production can take place is also a factor that affects the decision. The lower income in this transition period can be seen as investing in future production possibilities and must be considered sunk cost.

Identification of these determinants in a theoretical general equilibrium context will also give information of the data needed to implement the theoretical structure into a quantitative model framework.

Implementation of the theoretical structure in the applied model and construction of consistent data.

The further development of the national Danish General Equilibrium Model into a dynamic specification builds upon well-documented methods used for similar models. The major development in this part of the work packages is the implementation of the agricultural specific theoretical dynamics features mention under 1, as well as the construction of a consistent data material based on cost structures for organic farming found in work package 2 and behavioural parameters in work package 3. Information obtained in this research project and in other research projects is used to implement environmental indicators for emission of nitrogen, phosphate and potassium as well as energy related emissions into the model. This means that any scenario can be supplemented with information in the change in these emission indicators.

Deliverables

D11: An SJFI-working paper documenting the theoretical structure chosen and the applied economic data and environmental indicators. The working paper will also discuss similarities and differences across organic sectors and across conventional and organic farming sectors.

D12: An SJFI-report describing the dynamic version of the AAGE model and a few illustrative scenarios focusing specifically upon the new features relative to the static version of the model.

It is the intention to publish an international article on the findings.

Milestones

1. Identification of the theoretical microeconomic model structure and associated data.
2. Data collecting of macroeconomic data such as capital stocks, investments and rates of return.
3. Data collecting of environmental indicators and adjusting them to the rest of the database and model.
4. Adjustments of farm level data for organic farm types delivered from work package 2.
5. Adjustments of behavioural parameters in CGE model according to results found in work package 2 and 3.
6. Programming the dynamic version of the general equilibrium model and 'fitting data to that structure'.
7. Testing the implemented dynamic model.
8. A fully operational dynamic version of AAGE general equilibrium model documented.

WP5: Economic analysis of organic farming at the sector and macroeconomic level

Workpackage number:	4
Start date or starting event:	1.6.2002
Responsible person:	Lars-Bo Jacobsen
Contributing persons:	Søren E. Frandsen
Person-months:	17,5 (0,935 mill. DKr.)

Objectives

1. To construct a credible baseline scenario and identification of major determinants behind the development of organic farming the coming years using the developed dynamic general equilibrium model as described in work package 4.
2. To design and undertake a number of policy scenarios ranging from changing market situation for organic products, introduction of environmental motivated taxes or quantitative restrictions on conventional farming to different regulatory changes facing conventional and organic farming (the specific choice of scenarios will be done later).

Description of work

The line of work includes the following:

1. Baseline construction and identification of major determinants behind the development of organic farming.
2. Policy scenarios

Baseline construction and identification of major determinants behind the development of organic farming.

The construction of a baseline scenario gives a detailed description of the economy on a year-by-year basis. In relation to organic farming the baseline will allow for an identification of the major factors affecting the development of organic farming, the magnitude of these factor and their interdependencies. The information is beneficial when considering new policies targeted at the development of organic farming.

The baseline is calculated taking into account the present policy, decided policy and various trends in the economy.

Policy scenario

Conducting scenario analysis with a dynamic model which incorporate the mentioned theoretical features, will give important insight into the nature of the adjustment difficulties and cost associated with various policies in both the short and longer term.

Deliverables

D13: An SJFI report analysing a number of different scenarios, including a baseline scenario describing possible future developments of organic farming in Denmark focusing among a number of things on the relative competitiveness of organic farming relative to conventional farming and other industries in the Danish Economy. A relative large number of policy scenarios will also be conducted and implication for the design of agricultural and environmental policies will be discussed.

D15: An SJFI report concluding on the overall project with its main focus on the overall results found in the research project – from field level to farm, regional and sector and macroeconomic level.

It is the intention to publish an international article on the findings.

Milestones

1. Identification of principles for constructing a baseline using the dynamic AAGE model
2. Identification of major determinants behind the development of organic farming
3. Identification and design of baseline scenario and policy scenarios.
4. Undertaking simulations and undertaken sensitivity analysis.
5. Documenting the work and the results found in research report and in popular and scientific articles.

7. Implementation and time schedule

Table 3: Deliverables list

Deliverable No	Deliverable title	Delivery date	Meeting	Nature
D1	Existing labour use and machinery systems – state of the art.	1.12.2001		W. paper
D2	Labour use and machinery systems in organic farming -with focus on innovative technologies.	1.06.2002		W. paper + database
D3	Whole-farm analysis of labour and machinery demand for new technologies	1.06.2003		DJF report
D4	Cost estimates for labour and machinery, new technologies	1.09.2002		W. paper
D5	Description of new Ø-Plan model	1.10.2002		W. paper
D6	Mid term Workshop – presentation and discussions of preliminary results	1.06.2002	Workshop	
D7	Economic farm level analysis of different scenarios	1.10.2003		SJFI-report
D8	Final delivery of farm level data for the sector analysis	1.02.2003		W. paper + database
D9	Sector econometric model extended with organic farming, including determination of behavioural parameters.	1.02.2003		W. paper
D10	Baseline and scenario analysis using ESMEALDA with a regional perspective on the development of organic farming	1.10.2003		SJFI report
D11	Documentation of the theoretical structure of the dynamic AAGE model	1.11.2001		W. paper
D12	Documentation of dynamic ‘organic version ‘ of the AAGE model and illustrative scenarios.	1.06.2002		SJFI report
D13	Baseline and scenario analysis using AAGE	1.10.2003		SJFI report
D14	Final Policy Workshop – presentation and discussions of results and policy implications	1.10.2003	Workshop	
D15	Final report from the overall project	1.01.2004		SJFI report

Table 4: Time table (EXCEL FILE), see at the end of the document.

8. Collaborative partners

WP1 will be associated with a number of ongoing research projects within The Danish Institute of Agricultural Sciences (DIAS), for example:

- the fertility of the soil in relation to organic cropping praxis and soil treatment
- weed control and bed out of organic beets
- row cropping system: Technology for plant sowing and plant care
- weed control in row cultivated crops
- soil treatment and the influence of the rotation of crops for the function of the soil

It is characteristic for the above-mentioned projects that registrations of implemented treatments, yields, applied technique, traction measurements, etc. are already carried out. These registrations may directly form the input for labour and machinery analyses, but also selective work-studies may be carried out within the context of these projects.

Internationally, WP1 and WP2 will be associated with a possible EU-project “Labour in Organic Agriculture: Assessing and enhancing labour and social dynamics, farm-household performance, and rural develop-

ment”. The project is a collaboration between the Netherlands (Co-ordinator – WAU/IMAG/DLO), Denmark (DIAS-DAE/SJFI), England (WIRS), Italien (UP), Ungarn (DFMM/AESD/DESPS) and Schweiz (FIBL).¹ The main objective of the project is to diagnose the demand for labour and supply of labour, assess labour quality (physical and psychical), estimate sociological and economic consequences in the conversion to organic agriculture and subsequently prognosticate the mentioned factors on whole-farm basis for different farm types.

WP1 will use information and experiences obtained from international contacts and co-operation (e.g. CIGR-Working Group 17: “Models, Methods and Database for Labour and Machinery in Agriculture” with participants from Germany, The Netherlands, Finland and Denmark).

The work will also be carried out in co-operation with the Danish Agricultural Advisory Centre in Skejby.

There will also be co-operation with other projects focusing on scenarios on nutrient flow on organic farms. Such findings for conventional farms have previously been used as input for combined economic and environmental modelling (Jacobsen et al., 1998).

WP2-WP5 will be able to draw on a number of international capacities in the relevant research areas as SJFI participates in a number of international research projects and has done so for now quite some years. Especially the development of the sector econometric model and the dynamic computable general equilibrium model will potentially involve co-operation with foreign researchers. If possible an Australian senior researcher from the Monash University will be linked to the project assisting in the development of the dynamic version of the AAGE model.

Finally, it is the intention to co-operate with other research project under the ‘Organic Farming Research Program 2000-2005’, for example the project analysing the future market situation for organic products in Denmark and abroad (‘Forbrugernes interesse i økologiske fødevarer’). This would allow the present research project to capitalise on some of the research results with respect to the demand for organic products the coming years and thereby allowing for an analysis of the interaction between the supply and demand side of organic farming.

¹ WAU = Wageningen Agricultural University, Holland
IMAG = Institute of Agricultural and Environmental Engineering, Holland
DLO = Dienst Landbouwkundig Onderzoek, Holland
WIRS = Welsh Institute of Rural Studies, England
UP = Università degli Studi di Perugia, Italy
UHFH = University of Horticulture and Industry, Hungary
FIBL = Research Institute of Organic Agriculture, Schweiz

9. Budget, 1000 DKr.

DIAS-DAE	2000	2001	2002	2003	I alt
Salary (scientific)	36	201	201	164	602
Salary (technical)	0	111	111	67	289
Operation	13	104	104	55	276
Overhead	10	83	83	57	233
Total	59	499	499	343	1400
SJFI-FARM					
Salary (scientific)		404	404	404	1212
Salary (technical)		25	25	25	75
Operation		88	88	88	264
Overhead		103	103	103	309
Total		620	620	620	1860
SJFI-POLICY					
Salary (scientific)		507	507	507	1521
Salary (technical)		40	40	40	120
Operation		112	112	112	336
Overhead		131	131	131	393
Total		790	790	790	2370
Total	59	1909	1909	1753	5630

10. References

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Kristensen K. & Jensen J.D. (1999) “Danish Farmers’ Adjustment Capabilities – The Case of Fertiliser Regulation”, Danish Institute of Agricultural and Fisheries Economics, working paper no. 2/99, February 1999

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Appendix: CV's of central persons, and description of role, qualifications, capacity and experience of each participant including maximum 5 relevant papers (max. 5 pages).

Partner: Danish Institute of Agricultural and Fisheries Economics (SJFI), Denmark

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The Danish Institute of Agricultural and Fisheries Economics (SJFI) is a sector research institution under the Danish Ministry of Food, Agriculture and Fisheries covering all aspects of economics concerning agriculture, horticulture and fisheries. It employs 60-70 staff and carries out economic research and provides professional advice on issues related to the agricultural and fisheries sectors. The Agricultural Policy Research Division analyses the economics of the agricultural sector, its relations to other sectors of the economy and the impact of agriculture on the environment. National and international economic conditions are an integrated part of the Division's research. The Farm Management and Production Systems Division, has as its major aim to produce and communicate economics knowledge in enterprises. It aims furthermore to analyse economics and market potential for new agro-industrial products and the interaction of economics, environment, landscape, health and animal welfare with regard to alternative production methods and technologies.

Project co-ordinator

Research Director, **Søren E. Frandsen** is specialised in the development of economic models, the analysis of the common agricultural policy and global economic analysis. He was a member of Governmental Pesticide Committee (Pesticidudvalget), Ministry of Environment and Energy, 1998-99 and contributed to the economic analysis undertaken for that committee, including the macroeconomic study of organic farming. He is a member of the Working Group discussing WTO issues of relevance for the Ministry of Food, Agriculture and Fisheries and he is presently undertaking the analysis of the Future Perspectives for the Danish Agricultural Sectors and the Processing Industries for the Ministry of Food, Agriculture and Fisheries. He is also member of the Board of Directors, Research Centre for Organic Farming (FØJO).

Senior Researcher **Brian H. Jacobsen** is specialised in economic planning with focus on farmers' decision-making behaviour. Research methodology has involved non-parametric analysis as well as qualitative approaches. Other research topics include analysing machinery costs and modelling farmers' investment decisions. Current research deals with environmental economics and the costs of reducing N-leaching and ammonia emission, including work on an integrated economic and environmental farm simulation model (FASSET).

Researcher **Lars-Bo Jacobsen** is specialised in the construction of agricultural specific input-output tables and development of computable general equilibrium (CGE) models used for assessing the sector and economy-wide implications of changes of the structure in the economy. He undertook the macroeconomic analysis for the Governmental Pesticide Committee, Ministry of Environment and Energy, 1998-99, which also included a macroeconomic study of organic farming. Current research deals with the construction of a CGE model with an explicit modelling of organic farm enterprises in a static framework, which also involves a further disaggregation of the input-output table to take account of organic farming.

Senior Researcher **Jørgen Dejgaard Jensen** is specialised in agricultural sector modelling, regional economic analyses and agricultural policy, and he is responsible for the econometric agricultural sector model - ESMEALDA. Research methodology has involved theoretical as well as quantitative approaches, the latter including econometric modelling, model building and scenario analyses. Other research topics include environmental economics, model linkages. Current research deals with the impacts of agricultural activities on the local and regional economies in Denmark, as well as the impacts of agricultural and environmental policies on the agricultural sector.

Research Assistant **Niels Tvedegaard** is specialised in biological and economic connections. This knowledge he has used for his development of the farm simulation model Ø-plan. During this work he has obtained considerable experience in building economic models. Current research has included organic pig-, plant and poultry productions at the farm level.

Researcher **Jens Erik Ørum**'s most important fields are economic assessments of agricultural and environmental legislation with a focus on the farm enterprise, and use and development of decision support systems and geographical information systems for economic and environmental analyses of agricultural problems.

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DIAS is a research institution under the Danish Ministry of Food, Agriculture and Fisheries, covering agriculture and horticulture. DIAS has 11 scientific departments with 1125 employees. The Dept. of Agricultural Engineering (DAE) is part of the Research Centre Bygholm, which also comprises an Ecological Research Station. DAE focuses on the technical aspects of agricultural buildings and machinery. Technical aspects regarding machinery include analyses of labour demand, machine and energy requirements, the development of decision support tools, control and processing techniques, and the implementation and adaptation of sensory systems. Other important areas include soil tillage, crop establishment and plant protection, fertiliser

management and spreading techniques, non-chemical weed control and spraying techniques, harvesting, post-harvest management and storage.

Responsible scientist

Senior Researcher **Claus G. Sorensen** is specialised in operational technical farm management, including research concerning labour requirement, machine capacity, labour planning, labour profiles, etc. Analyses and models has been developed for both plant and animal production systems and models has been implemented in software programs (e.g. DRIFT). Current research includes a decision support system for operational planning of field operations and system analyses of the labour demand and machine capabilities for manure management systems. He is a member of the Governing Body of the National Society of Agricultural Engineering and a member of the European Society of Agricultural Engineers and has participated in international co-operation within the field of operational technical management.

Other scientists involved

Senior Researcher **Villy Nielsen** is specialised in labour research with emphasis on labour requirements, machine capacity, work budgeting, work profiles, work planning and labour environment. Current research include the analyses and modelling of labour and machinery requirements for different types of production systems on both field level and farm level. Implementation of the models has involved the program DRIFT. He is subcontractor of the EU project "Agrimach Multimedia" (Info2000 programme). He has been coordinator of the Technical Management Group and President of CIOSTA (Commission International de l'Organisation Scientifique du Travail en Agriculture) for the past two years.

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