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Start-up phase of the LEI microsimulation model

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Contents

General introduction

This report describes the first part of the start-up phase of the development of a microsimulation model for LEI. Previous studies (e.g. Baltussen et al., 1998) advised LEI to build a microsimulation model, based on the knowledge contained in the currently available micro models. The objective of this start-up phase is to write a project set-up for the development of a microsimulation model. This microsimulation model is expected to fulfil a central role as an engine for farm data based research at LEI, and is expected to have a lifetime of around 10 years. This model will use micro data of individual farms (for instance data contained in 'boekhouding 2000'). The future microsimulation model should be able to provide answers to similar questions as are currently dealt with microdata models at the institute. Therefore, this model should be able to provide two types of answers: 1) policy related questions of the major clients of LEI, and 2) projections of future developments at the farm level. There are currently two models in operation at LEI that use micro data: The Financial Economic Simulation Model (FES) and APPROXI. Both models can be characterised as microsimulation models, albeit that their theoretical background, coverage and areas of applicability differ. The LEI management needs advice whether the best option is either the development of a new model or the improvement of the currently used models.

The layout of this report will follow the phases in the development of simulation models as is the proposed standard for LEI from now on. In appendix 1 the distinguished phases in this development process are presented (in Dutch).

The final project set-up will contain the following elements:

- a description of the context in which the model has to perform. This description provides the desirable functionalities of the model;
- a rough conceptual model in which is described which desirable properties of the model are transformed into requirements (part of the domain analysis);
- a rough planning in phases of the total trajectory to develop a microsimulation model en the results of each phase. The risks that accompany this development are described briefly;
- the project set up will provide a more detailed phasing of the first phase.

The final version of the report on the start-up phase of the LEI microsimulation model is divided into three parts. (i) We start with an assessment of the context in which future this model has to perform. (ii) In the preliminary conceptual plan the economic architecture of the model is presented [to be completed] (iii) Finally, the project set-up for the remaining trajectory of the development of a microsimulation model is described [to be completed]. In this version of the paper the first part of our analysis is elaborated.

1. System context analysis

1.1 Introduction

The first step in the development of a microsimulation model is the context analysis (see appendix 1 for partitioning of the development process). To describe the system context of the model, we first identify market possibilities for (LEI) microsimulation models (MSM) in section 1.2.

We start with an inventory of the research questions dealt with by the current MSM models in operation (FES and APPROXI). This inventory is based on internal documents already available, and (b) interviews with LEI model responsibles ('materiedeskundigen'). To this end the turn-over of the currently used MSM models is analysed to indicate the future market possibilities. We find that by far the most important client is the Ministry of Agriculture, Nature management and Fisheries. Therefore, we focus on the future policy questions of this Ministry, formulated by their key LEI responsibles. We are fully aware of the fact that this may introduce a bias into our assessment, since we do not cover other prospective clients, such as other Dutch Ministries, farmer's associations and local governments (provinces).

Thereafter requirements are formulated with respect of the application of the future MSM model. Questions to be answered are: who are the designated people to run the model? Should the model be accessible for people outside LEI also? How are the requirements defined with respect to the inputs of the model? How should the model be connected with other models inside and outside LEI.

The future policy questions are confronted with the models currently used (by LEI). This results in a selection of the policy questions to be dealt with by the MSM models and policy questions that have to be answered by means of other models (e.g. sector models).

In this first part of the start-up phase it is not yet possible to provide a complete cost benefit analysis. Only after the project set-up for the remaining trajectory has been determined, is it possible to make a more reliable comparison of forecasted revenues and expected costs. In the current document, we confine ourselves to a qualitative comparison of benefits and costs between the three alternatives available: 1) 'business as usual', 2) improving the currently micro models, 3) developing an entirely new MSM.

1.2 Market (users) for the model

1.2a Current research questions

Financial Economic Simulation model: FES

FES has been used on a regular basis over the past years as a tool for evaluation of financial-economic impact a policy change on various farm types. The area of application of FES can be summarised as 'impact analysis'. That is, the model traces the financial impact of a policy change down to the level of the individual farm. The policy changes typically consist of:

a) fiscal measures;
b) environmental regulations and animal welfare regulations.

The analysis typically concentrates on financial implications of policy induced investments at the farm level. Laws and regulations are translated into required investment at farm level. The model determines which farm can bear these investment outlays.

In addition to delivering numerical results, in a typical FES research project the model serves to focus the attention of the project team on the analytical questions at hand. The model therefore is also an 'organiser' of research.

APPROXI

Assessment of effects of policy changes on financial perspective of dairy farms and on environmental pressure are the typical questions that have been addressed by APPROXI in the past years. The model is routinely used to trace out likely medium-run consequences of policy changes such as:

a) nutrient loss standards (MINAS);
b) taxes and subsidies relevant to dairy farming;
c) effects of restricting livestock units.

Contrary to FES, the APPROXI model incorporates behavioural responses to policy shocks. It therefore goes a step further than the impact analysis approach of FES. Although there seems to be some overlap between the two models with respect to the type of questions addressed, the emphasis of APPROXI is slightly different, as this model incorporates endogenous behavioural adjustments as response to policy shocks.

Information from the project information system was used to obtain the turnover of both models. The total turnover of research in which one or both models are employed was 1.86 million NLG in the period 1996-1998. About 960,000 for APPROXI and 900,000 for FES (without double counting). If we focus on research for which the models were essential, the turnovers are 700,000 and 650,000 respectively. The Ministry of Agriculture, Nature conservation and Fisheries was by far the largest consumer of projects based on both models. Ninety five percent of the (essential) research with APPROXI was financed by this Ministry. This percentage is for FES fifty eight. These turnovers may be slightly underestimated. The research capacity of these models was effectively limited to the prime model developers themselves.

1.2b Future clients and research questions

In order to assess the direction and size of future demand for micro data based modelling results, by this most important client we interviewed key-account managers at LEI for the Ministry of Agriculture, Nature management and Fisheries. This round of interviews resulted in a rather long and (not surprisingly) unstructured list of various topics, that reflect the current flavour in agricultural policy making. The prospective research topics are summarised below as belonging to two areas: (i) policy evaluation (ii) projections of 'exogenous' developments at farm level.

Policy evaluation

- Consequences of WTO agreements.
- Consequences of Agenda 2000 - reorganising the sector ('herstructurering').
- 'Broadened' agriculture (multi functional agriculture) e.g. recreation on the farm.
- Economic effects of policy options (restrictions on pesticides).
- Supply chain.
- Organic farming.
- Environmental policy.
- Targeted farm subsidies (e.g. support for environment friendly farms).
- Regulation using fiscal incentives (e.g. tax investment credits).
- Policies to support regional development.

Exogenous development

- Development of the number of farms (by farm type).
- Modernity of farms.
- Farms of the future.
- Leaders and laggards.
- Relocating farms.

The *'Exogenous development'* topics show that the Ministry is not interested in consequences for the average farm but more in the diversity of consequences across farms (e.g. leaders and laggards, farms of the future). The diversity is emphasised recently because on the one hand it is recognised that regulations affect different farms differently, on the other hand it is known that farms react differently on changes in their environment (Baltussen et al., 1998:5). The Ministry's interest in the variation across farms can also be seen in the presentation of the results by the current micro models.

Most interest with respect to FES research is on the number (or percentage) of farms that gets into financial stress due to the alternative policy scenarios. Also a description of the average farm is demanded and sometimes more elaborated distributions are requested. This information is requested for several farm types (e.g. specialised dairy farms).

APPROXI computes the policy effects for individual dairy farms. Aggregation of results depends on the client's wishes on selected groups of farms (region, specialised versus non-specialised, etc.).

Both models can generate distributions (with respect to certain characteristics), but clients do not regularly request this type of output. The customer's focus is currently on exact results (point estimates), and do not display much interest in uncertainties (see also the RIVM affair). However, it is expected that in the future the uncertainties that surround model results have to be presented more explicitly.

The inventory of future questions and clients is based on the current experience of LEI account managers, and is therefore somewhat limited in scope. Within the Netherlands, there may be other prospective clients, such as local governments, other Ministries (Treasury, Economic Affairs), and Farmer's associations. Within Europe, policy decision making authority is increasingly transferred from The Netherlands to the European level. This implies two things: first, the Dutch market for government funded policy research cannot be assumed to grow dramatically, second, it can be expected that there will be an increasing demand for micro based policy impact analysis from the European level of policy making. However, a few problems arise (i) the EU does not like to fund policy impact analysis, during the policy formulation process (ii) RICA data are not as detailed as the Dutch FADN data (iii) Rica data are not representative for European agriculture. Next to outside clients, there may be a LEI internal client base for microsimulation models. By consistently organising available micro data information, a new microsimulation model can facilitate a better understanding of the main mechanisms in Dutch agriculture. It enlarges the analytical basis of LEI and it can provide a structure to discover research areas that are now not covered at LEI.

Other extensions of market possibilities are the annual forecasts made by LEI. This 'look-ahead' to the coming year can be one of the first deliverables of the new MSM.

It is expected that within the expected life-time of the future MSM these policy questions will change. Therefore it is necessary to formulate requirements for the MSM, to enable possibilities for rapid adaptation to new policy questions. If the MSM is flexible and if it simulates the entire agricultural sector with sufficient detail, the MSM can be adapted for tailor made simulations of any relevant policy impact analysis. Potential clients can best be contacted when a basic version of the MSM is developed. Then we can show them the possibilities of a simple version of MSM and interest them in funding research to analyse specific policy impacts.

1.3 Application requirements

User-requirements

Non-expert use: given that calculations and analysis based on micro data is a core activity of LEI it is highly desirable, and even imperative, that microsimulation modelling tools are accessible to a wide range of researchers within the institute. That is, the set of model user is larger than the set of model builders.

Self-contained: a widespread use in the institute requires a user-interface that provides the user with all the information on how to use the model. This is surely very demanding. A well designed microsimulation model can fulfil a similar role for analysis as the role that Word fulfils with regard to text processing.

Version management and maintenance: The user must have the assurance that he works with the most recent and up-to-date version of the model and its associated datasets.

Well-documented: widespread use within the institute places more demands on model documentation. Informed use of the model is only possible if all aspects are well documented and the documentation is up-to-date. This holds both for the model equations and the database.

Distributed use: following recent trends in modelling, it may be a possible that the model will be used in a distributed way by outside users (others than LEI researchers), for instance by staff members of the Ministry of Agriculture or other clients. If this route is followed, this means a greater burden on the user-interface part of the model and the set-up of a user support system.

1.4 Constraints regarding the data

- Periodic availability: it is essential for the long-term viability of a model that all data inputs are available on a regular basis, that is data must be updated periodically.
- Acquisition of lacking data: if some of the inputs are not regularly available in the current data collection frameworks (like prices), a separate project should be defined to fulfil this task.
- Data storage: all inputs should be well stored in standard database structures, and should also be fully defined. This includes full documentation of data sources and data processing procedures applied to raw data.
- Data quality: the quality of the input data over time has to be monitored.

1.5 Related models

The future microsimulation model will be used in an environment in which other models are used as well. Figure 1.1 presents an overview of the different models presently in use by LEI.

- *The World* and *Europe* (see figure 1.1) are covered by general equilibrium models like GTAP and FEA/CAPMAT. The results of these (macro) models can be input for models at a lower level in the funnel (e.g. sector models).
- Consequences for the Dutch agriculture sector can be computed with sector models like DRAM. The results of these sector models could be input for the MSM to model adding up conditions (market clearing). The MSM can also compute the first order and second order effects of policy alternatives for individual farms (without the use of sector models).
- *Farm level* models suited best to compute policy implications of farm specific policies. The impact of agro-environmental policies depends on farm characteristics,

only a MSM can deal with the diversity among farms. Exogenous developments can be projected on individual farms.

- It should be noted that we also have a number of partial economic and technical models that are not included in figure 1.1: Related to the level 'Netherlands': partial model of the bovine meat market (Rundvleesmodel, Myrna van Leeuwen), partial model of grain market (Graanmodel, Jan Blom). Related to the level 'Farms': technical submodel manure flows 'Mesten Ammoniakmodel; Stofstromenmodel', technical-economic model greenhouse energy (Energiemodel, Nico v/d Velden).

Technical models developed outside LEI will fit into the latter category of models (models at Staring Centre, AB etc.).

Clearly, the largest part of our modelling expertise of LEI lies at the micro level of the farm, followed by the European level.

1.6 Confronting market with models

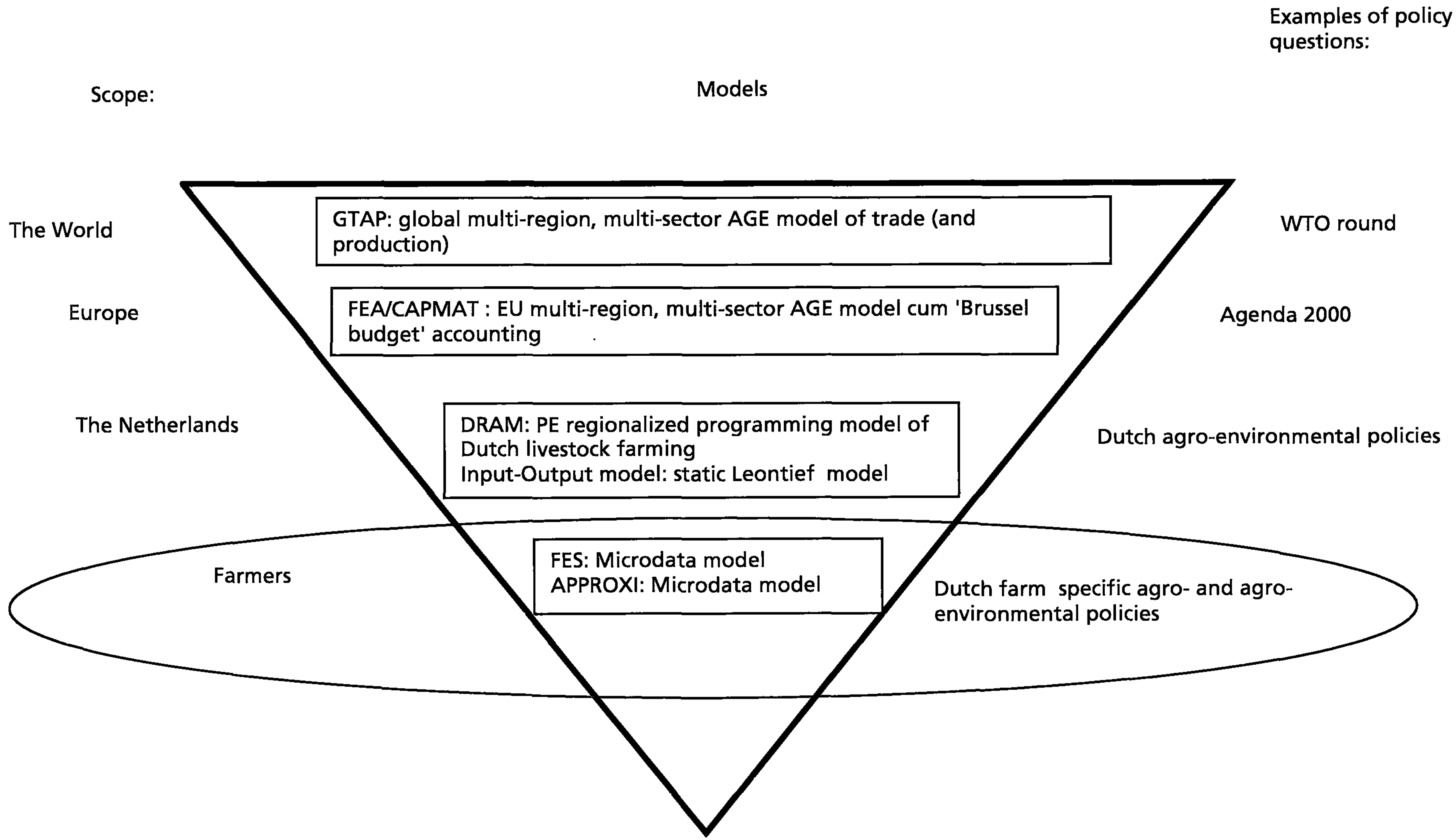
The aforementioned policy evaluation research topics can be distinguished according to their position in the LEI research funnel, see the LEI economic modelling figure below:

1. topics largely exogenous for the EU, originating from international agreements and international trade (e.g. WTO agreement);
2. topics largely exogenous for the Netherlands and for Dutch agriculture, originating from EU legislation and EU enlargement (e.g. Agenda 2000);
3. topics originating from policy choices for the Dutch agriculture sector (e.g. hog sector legislation, MINAS, restrictions on pesticides);
4. topics originating from exogenous incentives at agribusiness level or farm level. These exogenous developments may be influenced by the Ministry to improve the farm structure (e.g. supply chain, recreation, organic farming);
5. topics originating from interactions between farms and the natural environment (e.g. environmental pressure, nature conservation and management).

The 'mest en ammoniak' model can compute the consequences for the manure surplus. A farm model (alike the MSM) can compute the developments of farms in terms of input use and outputs In relation to the broader theme of supply-chain management: many issues arising in this context of vertical co-ordination can ultimately be translated into changing input- and output prices facing the individual farm. A farm-level MSM could take these as given (perhaps obtained from other modelling analyses, e.g. chain model [not depicted in the funnel]), and calculate the impact of alternative co-ordination mechanisms on the farm.

By placing policy questions at different levels of aggregation alongside the analytical modelling tools available at LEI, we also attempt to highlight the linkages between our suit of tools. While we do not advocate an explicit technical linking between the various levels, we see ample scope for informal linkages and 'loose coupling'. The policy impact research topics can be tackled at different levels of the LEI funnel. Results of models at a higher level (1, 2, and 3) can be used as an input in the MSM

Figure 1.1 The LEI economic modelling family: a tops-down approach



Then the MSM can focus on its most important virtue: the insight it offers into the diversity across farms.

1.7 Description of current practice

Introduction

This section describes the key characteristics of the two economic simulation models that currently use micro data. Both models can be characterised as microsimulation models. However, their theoretical background, coverage and areas of applicability differ. This section does not attempt a thorough review of the models, but rather highlights key features, relevant for the client. For details of these models we refer to Mulder (1994) and Hennen (1995). The table at the end of this section summarises the modelling characteristics in tabular form.

FES

The Financial Economic Simulation model (FES) can be characterised as a tool to evaluate first order effects of policy changes at the micro level of the individual farm. The model covers all agricultural and horticultural activities. The core of the model is a representation of the farm's business accounting scheme (profit-loss statement, cash-flow accounts and balance sheet). Given exogenous projections of farm revenues, factor costs, and taxes/subsidies the profit-loss account is constructed. Profit-loss accounts and investment outlays enter the cash-flow account. The latter is then used to update the balance sheet. Hence, the farms' accounting schemes is projected forward in time. The accounting scheme is used to derive several financial indicators, such as solvability ratios, which are used to assess the financial viability of farms.

The main behavioural component is the farm's investment financing decision. The farm's investment needs in conjunction with solvability indicators determine the feasible amount of investment outlays. The theory underlying the investment decision is the so-called pecking order approach. Farms have a preference ordering for financing of investment projects. Internal financing is preferred over external debt financing. The financing mix is governed by the farm's desired solvability position.

Policy changes are implemented in two ways: 1) indirect taxes and subsidies enter into revenues and factor prices, 2) policy changes that require the farm to change its production equipment are extraneously translated into investment requirements, which enter then as exogenous input into the model. Note that investments do not alter the farm's production possibility set, but do merely have financial implications.

A distinguishing feature of the model is its great amount of detail. First: the micro database on which the model operates enables the incorporation of the farm's individual operating characteristics, hence delivering a more accurate approximation of policy effects than models that take the average (representative) farm as point of departure. In other words, the model fully explores the heterogeneity found in the population of farms. This is particularly relevant as fiscal and financial policies are almost never formulated as advalorem measures or simple lump-sum transfers. Rather, the amounts of payments are contingent on the farm's specific situation (e.g. stepwise taxing schemes using tax brackets, exemption rules) [1]. Second, since the model's basic unit of analysis is the individual farm, it is able to generate the information on the distribution effects of policies. A type of information that is much wanted by policy makers (who are the 'winners' and 'losers'?). FES does not allow the farmer to adapt to changes in the exogenous environment, it only computes first order effects of policy proposals.

APPROXI

APPROXI is a knowledge based system applied to Dutch dairy farms. It is closely related to the approach of (management) decision support systems (DSS). The difference is that APPROXI attaches a positive interpretation to the normative outcomes of the knowledge based system. I.e. , farmers are simulated to adjust their behaviour to the 'advice' obtained from the DSS. The modelling of behavioural adjustments deserves some elaboration, since this is a quite unique effort to capture behavioural adjustments in agriculture: each individual farm is classified as belonging to one or several prototypes of farms. The classification uses fuzzy set membership, i.e. an individual farm is allowed to belong to

Model characteristics (content of the model)	*FES*	*APPROXI*
Unit of analysis (firm, sector,..)	Farm	Farm
Aggregation level of results	Farm types (see above)	Farm types (see above)
Time dimension (static, dynamic)	Recursive dynamic	Comparative static. The model takes one big step to adjust to exogenous changes. Time dimension enters through timing of exogenous variables.
Stochastics	No (yes in principle)	No
Modelling of decisions and behaviour		
Which theoretical paradigm is used?	The largest part of the model consists of accounting definitions. Behaviour is modelled only as regards financial investment decisions. This is modelled along the pecking –order model of financial decisions.	APPROXI is a knowledge based system. It is closely related to the approach of (management) decision support systems (DSS). The difference is that APPROXI attaches a positive interpretation to the normative outcomes of the knowledge based system. I.e. , farmers are simulated to adjust their behaviour to the 'advice' obtained from the DSS. Management styles ('bedrijfsstijlen') are used.

[1] This relates to the vast literature on the aggregation problem. See for example Stoker (1993) and Kirman (1992).

Modelling of decisions and behaviour	*FES*	*APPROXI*
Supply:		
Endogenous or exogenous?	Exogenous. The model needs exogenous inputs of annual revenues at the farm level. Revenues are not decomposed into price and volume components.	Endogenous
Production function?	No	Yes. Piecewise linear.
Substitution between inputs?	No	Yes. 'rules' E.g. reduction of feedstuff bought and more high quality feed grown.
Substitution between outputs?	No	No. (there are multi-output farms though)
Demand:		
Exogenous or endogenous	Exogenous. This is already incorporate in the exogenous assumption on farm revenues	Exogenous
Demand function ?	No	No
Substitution between demand categories?	No	No
Investment:		
If modelled, how?	Financial only. Investment follows from balancing replacement 'needs' (age of equipment) against financial desirability (solvability and liquidity constraints). Endogenously modelled investments are only replacement investments. Investments into expanding the existing capital stock may arise from laws and regulations (e.g. investments prompted by environmental regulations)	Yes. Investment in land and production quota.
Does investment affect production possibilities?	No	Yes.
Entry and exit:		
Can farms enter agriculture?	No	No
Can farms switch from one sector to another?	No	No
How is exiting modelled?	(1) Financial discontinuity. (2) death of farmer. Firms are 'zipped'. No impact on aggregate supply.	Via input from FES, which calculates financial viability of farms after one APPROXI iteration has taken place. Recently exit-characteristics (e.g. age) are implemented in APPROXI itself to approximate exit of farms in time

Modelling of decisions and behaviour	*FES*	*APPROXI*
Markets:		
Market clearing in input markets, output markets?	No	No
How are imports and exports treated?	No. Link with foreign markets is circuitously captured by exogenous estimate of annual farm revenues.	Not incorporated.
Model input		
Data sources (including indication of up-to-dateness)	BIN, SBE calculations, CPB forecasts of price developments, fiscal information, client's input	BIN, SBE calculations, Meitelling (matching algorithm!), CPB, NUM (?)
How are parameters estimated?	There are not many parameters in the model. If they exist, e.g. desired solvability, they are estimated econometrically or calibrated using expert information.	OLS estimates on BIN data for key parameters (reference parameters) Expert input
Model output		
Types of output variables (e.g. financial, real, units of variables..)	Profit-loss account, balance sheet, cash-flow account. Nominal NFL. Additional variables depending on research issue.	sector structure (size etc.) environmental balance sheet farm income sheets taxes and subsidies
(General) requirements for models (see the Bouma report)		
Consistency		
Tested	Model performance has been tested in early stage of development. It is unknown whether there have been later attempts, e.g. through 'backcasting'.	Unknown
Accepted	Yes, within institute and among clients. Degree of acceptance outside is unknown.	Within institute acceptance is hampered by a) unique DSS modelling concept, b) difficult accessibility of software. Acceptance among major client seems to be high.

several prototypes simultaneously, where the degree of set membership is captured by fuzzy thresholds. To each prototype, a set of behavioural rules is attached. The individual farm is then simulated to display a mix of these prototypical behavioural adjustments as a response to some exogenous events. This modelling of behavioural responses captures substitution effects in input usage. For example, farms may adjust their feedgrain mix as a response to certain environmental regulations. APPROXI is able to model adaptations of the farmer to changes in the exogenous environment; it can compute second order effects of policy proposals.

1.8 Cost-Effectiveness Present Models versus MicroSimModel

Given the continued demand for micro data based quantitative research of the type described in section 1.2, LEI has basically three options to organise its modelling tools. 1) 'Business as usual': continue with the present modelling environment, 2) implement the current FES and APPROXI in a new technical software environment, 3) construct an entirely new model. While option (1) is still available to date, it has already been decided that in one way or the other a reconstruction of micro data models needs to take place. Nevertheless, we present below an indication of the costs and benefits attached to all three options. It should be emphasised that both options (2) and (3) do not necessarily imply the in-house development of a completely new software environment (such as the ARTIS system that is currently being developed). It may be more efficient to utilise existing general purpose software for certain modelling tasks rather than attempting to construct our own development environment.

Aspect	FES and APPROXI old	FES and APPROXI to be rebuilt	MicroSim to be built
1. *Availability*			
- short term	+	- -	- -
- long term	- -	+	+
- build on ARTIS Data warehouse	- -	?	+
2. *Amount of costs*			
- (re)building		- - -	- -
- extension	- -	- -	-
- maintaining	- -	-	-
- linking with other models	- - -	- -	-
- configuration management	- - -	- -	-
3. *Effectiveness of use*			
- present questions	+	+	+
- future questions	- -	+	+ +
- combined questions	- -	-	+ +
- time to market	-	?	+
- usable by all researchers	- - -	?	+
- amount of questions usable for	- -	-	+
4. *Quality standards*			
- maintainability	- -	+	+ +
- extensibility	- -	+	+ +
- transferability	- - -	?	+
- IT standard	- - -	?	
- ISO standard	- - -	?	+

Comments on the cost effectiveness comparison

The above mentioned aspects are to be evaluated only in a horizontal way of comparison. That is, comparison across criteria is not valid.

Question marks are put in the column of the option 'FES and APPROXI to be rebuilt' because it is not clear whether the same Quality Standards (ISO and IT) have to be met by this option compared to the option of building the new MicroSimModel. If so, then the costs of rebuilding two models (FES and APPROXI) will be higher than the costs of building a new MicroSimModel.

Even if the standards for rebuilding the two models FES and APPROXI don't have to be at ISO level, the costs of rebuilding should not be underestimated as literature and also own LEI experience (Mest- en Ammoniakmodel) clearly show.

The aim of building one new model (the MicroSimModel) is to be able to address questions of a broader scope. It may be expected that such a model with an open framework is more extendable and therefore more able than separate (partial) models to answer future questions.

A continuation with present (old) software models of FES and APPROXI is not a viable options to answer future questions. The models will be soon stuck in their present software body, nor will they meet any quality standard.

1.9 Conclusions

Implications from market analysis of current models

It is striking to observe that a large portion of our modelling based turnover is generated by a model that is conceptually very straightforward. That is not to say that FES is a 'simple' model, one should not underestimate the amount of complexity introduced by taking into account individual farm characteristics and the host of rules and regulations that are in operation. However, the economic architecture of FES consists for the largest part of accounting rules. Modelling experts and account managers indicate that there will be a sustained -but not necessarily growing- demand for micro level impact analyses that is currently supported by FES. Policy makers like impact analyses because they can understand the mechanisms behind the calculations. In addition, this type of micro level modelling provides insight into the distribution of effects over 'winners' and 'losers'.

To prepare a solid base for the new MSM, the conceptual model as elaborated in the next phase of this project has to contain more than an accounting framework such as FES. The entire domain of the MSM has to be described. The interactions between the LEI models (also the partial economic and technical models not depicted explicitly in the funnel) will be depicted in this conceptual model. Also the links with technical research will be presented. However, as a starting point for elaboration of MSM, FES is suitable. In other words, the design of the MSM will specify the 'hooks' for further elaborations, but will start from a simple a core as possible.

At the same time, our clients express the need for more medium- to long term analysis. This type of analysis requires modelling of behavioural adjustments, e.g. changes in input demand, and modelling of market interactions. APPROXI goes some way in the direction of behavioural modelling, albeit confined to the dairy livestock sector [1]. We should admit, however, that LEI has very little to say on the issue of market modelling. Baltussen et al. (1998) have emphasised the need to incorporate market clearing

[1] APPROXI is currently extended to cover other agricultural sectors as well.

conditions. It is questionable whether the most efficient approach to this is a micro based bottoms-up approach, or rather a more traditional partial equilibrium modelling approach that delivers prices as exogenous inputs into micro data models, see e.g. Van Tongeren (1995) for a micro based approach. In section 1.6 above, we argued for a tops-down approach to market modelling.

Our customers seem not to attach too much weight to the scientific value of our models, but rather implicitly assume that the scientific value of the models used is guaranteed by LEI. However, this may partly be due to the fact that we have long established links with our main customer, the Ministry of Agriculture. The increasing importance of certification of R&D processes will force LEI to prove that models are built consistently and that the scientific content of models is approved by publications in international refereed journals. Especially for a model that will be developed, to be used the next 10 years, the theoretical principles have to be clear and well accepted within the scientific community, next to the client community.

Expanding the market of MSM

At the European policy level, research questions will -in the medium run- not be very dissimilar from the topics the Dutch ministry is dealing with, and hence the theories built into our modelling tools need not to be adapted dramatically. However, on a technical level, one should consider the delinking of data from model calculations.

Implications from confrontation market with models

The policy impact research topics demanded by the clients can be tackled at different levels of the LEI funnel. Results of models at a higher level (1, 2, and 3) can be used as an input in the MSM. Than the MSM can focus on its most important virtue: the insight it offers into the diversity across farms. Although it is tempting to incorporate as much as possible in the MSM, to keep the model manageble it should be kept as simple as possible. For instance market clearing can better be modelled at the sector model, the results of the sector model (e.g. prices) can be used as input in the MSM.

Implications from market and application

Another set of issues relates to the timeliness of producing model results. Not only do our clients demand a quick delivery of results, they are also less willing to finance model development [1]. This implies that we cannot spend months to adapt a microsimulation model for a specific question, as is frequently the case under the current situation. As is often the case with large-scale policy models, FES and APPROXI are continuously under development. A disadvantage of the current extensions is that the LEI users lose the overview of the model, and one runs the risk of producing uncontrollable results. This calls for clear modular models, which draw on the accumulated work done in the past.

[1] It seems to be inevitable that LEI enters into a a discussion on financing its future model development.

Implications from application requirements

An essential condition for a modular structure of the MSM is that an 'MSM manager' acts as a central moderator who decides which (and when) new modules are developed, and which modules are used to solve a particular question. The question of management and maintenance of the MSM model of the future certainly has to be discussed in more detail at a later stage. In the next phase of the start-up we will focus on this model architecture.

1.10 Recommendations

Market

- Market prospects allow us to build a flexible MSM of limited size.

Application

- The core of the MSM needs to be a clear model that is easy to understand and can be run quickly.
- The MSM should follow basic principles of modular software design.
- A careful assessment has to be made with regard to the choice of implementation software. It is not obvious that we should develop the entire software in-house. A combination of commercially available general purpose software tools is also possible. Whatever approach is chosen, it remains true, that the main challenge is the design of an appropriate modelling architecture.
- A MSM manager should be appointed to manage the use and extensions of the modular model.

Market and current practice

- The starting point (and prime emphasis of the MSM) should be a model for impact analysis, i.e. direct (first-order) effects.
- A trimmed version of FES can be used as the core (accounting representation of the farm).
- Other modules should take care of behavioural adjustments.
- A dissected version of APPROXI could be used as a starting point for the behavioural adjustment module.

Conclusion
- The aforementioned recommendations should be elaborated in the second phase of the start-up of the MSM.

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Abbreviations

APPROXI	Knowledge based simulation model (see Hennen, 1995)
DRAM	Dutch Regional Agricultural Model (see Helming, 1997)
FEA/CAPMAT	Future of European Agriculture/Common Agricultural Policy Modelling and Accounting Tool
FES	Financial Economic Simulation Model (see Mulder, 1994)
GTAP	Global Trade Analysis Project
MSM	Microsimulation model

Appendix 1 Phases in the development process of simulation models (still in Dutch)

Fasen in ontwikkelproces van simulatiemodellen

Fase	*Ontwikkelstap*	*Onderdelen*	*ISO*
Conceptuele fase	Contextanalyse	❑ welke eindgebruikers (markt) ❑ eisen gebruikers ❑ eisen aan exogene data ❑ welke andere modellen in omgeving	
	Domeinanalyse	❑ welke objecten spelen een rol ❑ welke processen zijn te onderscheiden ❑ welke volgtijdelijkheid zit in processen ❑ welke exogenen zijn vereist ❑ welke edogenen worden gecreëerd ❑ welke uitbreidbaarheid wordt verlangd	Review
	Domeinabstractie	❑ welk basisraamwerk is vereist ❑ welke objectabstractie is mogelijk ❑ welke procesabstractie is mogelijk ❑ passen uitbreidingen binnen raamwerk	
	Mathematisch model	❑ opstellen mathematisch model per versie ❑ math. model op basis van domeinabstractie ❑ math. model is basis voor model-engine	Review
Operationele fase	Architectuurontwerp	❑ kiezen platform ❑ bepalen communicatie met data en andere modellen ❑ vaststellen veranderlijkheid van componenten ❑ ontwerpen architectuur hoofdcomponenten	Review
	Detailontwerp	❑ analyse samenstellingen componenten ❑ opstellen objectmodel per component ❑ zoeken naar generieke softwarepatronen ❑ definieer interfaces tussen componenten ❑ definieer detailontwerp in UML	Review
	Implementatie	❑ kies ontwikkelomgeving ❑ maak testplan ❑ schrijf software per component ❑ test per (deel van) component ❑ implementeer variant-beheer	Review
	Verificatie	❑ doe systeemtest op goede werking software volgens definitie van het mathematisch model ❑ doe gebruikerstest op userinterface en modelvereisten	
Testfase Concept	Modelvalidatie	❑ bezie aan de hand van modeluitkomsten of het conceptuele model een goed model van de werkelijkheid is	Review

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