INFORMATION NEEDS AND ACCOUNTING IN AGRICULTURE

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ABSTRACT

INFORMATION NEEDS AND ACCOUNTING IN AGRICULTURE
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Two related papers on determining the requirements of farmers for financial information and the role of accounting as an information source. The first paper describes the role of accounting and identifies topics for further research. The second paper discusses the creation of an information model that describes the financial decisions of a farmer.

Accounting/Information modelling/Agriculture

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This report contains two related papers on farm accounting. The first one, titled "Using farm accounts: a survey and recommendations for further research" discusses the role of accounting and its associated problems in agriculture. It was written as a summary of a report in Dutch, to be presented at the EAAE Congress in the Hague, September 1990.

The second paper, titled "Determining farmers' financial information requirements" describes the Dutch project to create an information model of the farmers financial decision making. The author, being one of the project leaders on this project called 'Branch intersecting information model', forwarded this paper in a three week visit to the Department of Agricultural and Applied Economics of the University of Minnesota, St. Paul, U.S.A. in the summer of 1990, and presented it in a workshop organized by prof. R.P. King who holds the Fred E. Koller Chair in Agricultural Information Systems at the department.

The papers can be read in any order, but are related. One of the topics identified for further research in the first paper is the description of the relationship between decisions and information requirements. This is the subject of the second paper. According to that paper, one of the by-products of describing information requirements is the identification of blind spots in our knowledge. That is the subject of the first paper.

The Hague, February, 1991  
L.C. Zachariasse
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1. Using farm accounts: a survey and recommendations for further research

Abstract

Information is a prerequisite for decision making. Computerized management information systems for farmers often include financial information. In practice, the use of accounting data has not been very popular among farmers. The characteristics of the sector (such as the uncontrollable production process in small holdings) partly explain this situation. From a user point of view, however, financial accounting can be adapted to provide more decision-oriented and more understandable information. Areas for a potential improvement of farm accounting have been selected. Among others they include: more decision-oriented indicators, more emphasis on planning and interim-results, and better presentation of data.

1.1 Introduction

Information plays a central role in decision making. Therefore, one would expect a major interest from farmers for accounting data. In practice however, the use of accounts seems not to be very popular among farmers. This paper examines possible causes for this lack of interest and makes recommendations for the improvement of the information-value of accounting data.

The next section reviews the literature on the use of accounting data by farmers. In section 3 we look for differences between agriculture and other sectors; these differences help to understand why the traditional accounting-principles do not always raise interest with farmers. In the literature some additional explanations on the low market-share of accounting information have been mentioned. They are discussed in section 4. The paper ends by looking into the future. Farming in the European Community will become even more capital intensive and, due to the results of research and the introduction of computers, the need and demand for information will grow. Accounting has to adapt to become a successful management tool for farmers. In the last section, some recommendations are made.

1.2 On the use of accounts

Information on the use of accounts by farmers is scarce. The last census on keeping accounts in the European Community stems from 1979 (Eurostat, 1985). Figure 1.1 gives the results for five...
countries. Of all farms only 10% (Germany) to 40% (France) kept accounts, with accounts defined as a systematic registration of cashflows which led to a calculation of the profit of the farm. In all countries mentioned there was a correlation with the size of the farm, but even on the biggest farms one in five did not keep accounts. The figures for Belgium and Luxembourg were disappointingly low. For Belgium Everaet (1985) concluded that despite heavy national promotion for accounting in agriculture less than 15% of the farms kept books. On intensive types of farming (horticulture and intensive livestock), on larger farms and with farmers who are above average educated, the penetration of accounting was higher. A lot of farmers regard accounting as a difficult activity that consumes a lot of time with a low yield.

![Figure 1.1 Percentage of farmers that keep accounts, 1979](image)

In the south of England, Lewis and Loader (University of Reading, 1986) conducted a survey according to which half of the farms used a 'fieldbook' to note down the operations and used materials. Also 50% used a cashbook which could be analyzed. Only 36% of the farms calculated gross margins, but 75% calculated physical yields per hectare or per animal. 'In many ways it is the number of farmers in different categories that do not keep records or who make no apparent use of such records that provides most food for thought', concluded Lewis and Loader.

Commenting on the division of decision making in farming couples, Darque (1988) noted: 'in effect, bookkeeping is often perceived as a tedious task that is necessary for financial reasons and in order to give access to certain types of financial aid. This work is willingly left to the women'.

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Keeping accounts and using them are two different things. That topic is seldom discussed in the literature, although doing so would make sense because in some countries farmers are obliged to keep accounts for fiscal purposes. All Dutch farmers face that situation, and most of them restrict their effort to a fiscal profit- and loss account and balance sheet. Most of the 25% of German farmers that keep accounts are obliged to do so for fiscal purposes (Agrarbericht, 1989). For France, Kroll (1987) concludes that the farmers' decision to keep books is heavily influenced by fiscal and administrative obligations. He also notes (Kroll, 1985) that the fiscal purpose has a negative influence on the usefulness for management.

In recent years data on the introduction of management-computers in agriculture have been published (Jennings, 1985; Putler and Zilberman, 1988) and most authors mention a slow introduction. Data and arguments show a remarkable resemblance with the situation in farm-accounting: software is said to be too retrospective and too descriptive (Berg, 1985), too much oriented to storage and retrieval of data and too little oriented to the calculation of statistics and management-support (Folkerts, 1985), not enough future-oriented (Zachariasse, 1985), not a tool for analysis (Attonaty, 1985) and demands too much learning and data-entry (Folkerts, Portiek et al., 1986).

Before we examine in detail the possible explanations for the lack of interest in farm accounting, it is tempting to discuss the relationship between accounting and farm results: does the use of accounts lead to better results? Although all authors on farm-accounting implicitly assume such a relationship, no research could be found in which the assumption had been tested. A recent study in Dutch horticulture (Alleblas, 1988) showed that farm-results depend on the level of management. At the same time differences in the use of accounts and the calculation of ratios (e.g. prior to an investment-decision) were observed. However the keeping of accounts as such did not seem to be correlated with farm results. Using them in a proper way is more important: 'it was showed that recording-activities must lead to a chain of activities in which, besides the registration itself, the evaluation afterwards is a crucial element. Without this evaluation the influence on the farmreturn is zero' (Alleblas, 1988; my translation-kjp).

1.3 Agriculture: some characteristics

Agriculture has some characteristics that give it a special status, not only in economic theory but in accounting as well. Some of these characteristics explain the low penetration of accounting in agriculture and are sometimes easily forgotten by those who plea for more accounting and more management computers in agriculture. A short overview shows the following characteristics:
Being tied to nature is the most essential one. It results in changing and unpredictable outcomes of the technical production process. In the case of perishable products this uncontrollable production process can lead to sharp movements in prices, especially for products with a low price-elasticity of demand. The fact that the agricultural production can be quite uncontrollable, means that the need for control-information is relatively small. An additional relevant fact is the seasonal character of the production process which decreases the need for (quick) feedback-information. It also makes specialization and division of labour difficult. 'The adaptability to EDP-technics and procedures differs per type of farming and depends largely on the suitability to measure, to check and to correct the production process on short term' (Zachariasse, 1985).

Being tied to the land. For most agricultural production processes, land is indispensable. Not only the quality of the soil is important, but in addition the production process has a spatial dimension. Distance is a cost factor: compare Von Thunen's model for land values. Land (quotas apart) are the most fixed asset, which accumulates the expected income capacity (Ricardo's rent-theory). That results in marginal remunerations for the other production-factors. This situation makes it difficult for accountants to value assets and unpaid costs. It is fortified by the big differences in farm incomes. Farmers who are an expert in the uncontrollable production process and have above-average incomes are able to make high bids for land, especially if they 'calculate' with a low opportunity cost for their own labour or (due to a low time-preference or a high marginal tax rate) capital. Another aspect of the importance of the land is that farmers live where they work: it is difficult to draw a boundary between work and spare time. Gasson et al. (1988) noted that farmers tend to attach a lower utility to spare time than workers do.

Small holdings. The seasonal production process and the spatial extensiveness make it possible for efficiency of scale to be quickly realized. In addition, adjustments to the necessary scale of production can be made by buying services (contractor, veterinary, accountant) or by concentrating on the central production process, leaving the buying, selling and processing (e.g. cheese) to other parts of the agri-business-complex. As a result accounting is only of small importance: decisions on some business-functions (like selling) are not taken by the farmer and therefore do not need any support. The decisions made by the farmer can be easily overlooked and the number of management-decisions (in contrast with technical production decisions) is low. Accounting-activities are mostly shared out, which results in a certain distance between the farmer and his records.
Small farms are family farms. That means that profit maximisation is not always the aim of the business and that decision making is not necessarily rational. We come back to these aspects later on.

Marginal remuneration. The fact that in relatively small holdings a large part of the labour and capital is provided by one family and that the land, being the most fixed asset, accumulates the expected income capacity means a deviation from the neo-classical theory of the firm. Not the marginal return of the individual production factors but the remuneration for the total complex of family-input steers the allocation. This is helped by the fact that it is difficult for farmers to judge long-term structural developments (the cob-web theory) and that it is difficult to employ their labour elsewhere (low salvage value).

Profit maximisation and decision making. Profit maximisation is not the one and only objective of the decisionmaker. Simon's 'bounded rationality', with a satisficing behaviour using standard operating rules (heuristics) and trial and error procedures is just one example. Lindblom's 'science of muddling through' which states that (in the words of Keen and Scott Morton, 1978) 'policymaking moves away from ills rather than towards predetermined objectives' is another. In agriculture the debate on the objective(s) of the farmer and his process of decisionmaking has also not yet come to an end. Gasson et al. (1988) noted: 'as non-wage labour, family workers also face another potential source of tension in a cash -economy. Rates of pay and decisions on the purchase of expensive consumer goods have to be negotiated, or at any rate determined, between members of the family'. They also concluded that objectives are influenced by the family life cycle. Blanc (1987) and Pollak (1985) made similar remarks. The literature on the aspects of risk on decisionmaking in agriculture is extensive (e.g. Petit, 1980).

Questionnaires on the objectives of farmers face a lot of methodological problems (Von der Ohe, 1985). Gasson (1973) concluded however that farmers in East Anglia in the beginning of the seventies had strong intrinsic value orientations. Farmers with larger holdings however seemed to be more economically motivated. Zachariasse (1974) noted that objectives of Dutch arable farmers are influenced by the level of income. As in Maslows scheme, new objectives arrive when earlier ones are fulfilled. Von der Ohe (1985) tentatively suggested that financial independence and subsistence security may be more important among economic objectives than profit maximisation and increasing net worth. In Alleblas' (1988) survey in Dutch horticulture 71% of the farmers mentioned an economic objective (especially profit or income) as most important. The other 29% mentioned a more social objective like a being independent. A study in Dutch dairy farming (De Hoop et al., 1988) concluded that farmers translate
their objectives into main points for management and into concrete indicators like gross margin or milk per cow.

1.4 Shortcomings

The special characteristics of agriculture make it difficult for accountants to keep their customers satisfied. The small holding with a relatively uncontrollable and technical production process in which 'profit' can be a difficult concept seems able to exist without much accounting-data.

Some authors have (correctly) argued that researchers and accountants are also to blame. Christensen, Lund and Pedersen (1984) concluded that the interest of farmers is mainly focussed on the bio-technical process and that the use of economic information is defective. That is mainly to blame on the impossibility of farmers to place themselves in accounting- and budget practices because they do not sufficiently understand the basic concepts and definitions. As a result of a historical process, the authors stated, these are moreover directed too much at research and policy-making.

In France, Brossier et al. (1984) made a similar remark: 'In general in France the studies to calculate the profits of farmers to support agricultural policy-making has not favoured micro-economic work. The example of the Farm Accountancy Data Network is revealing.'

More or less the same is true for the Netherlands. In the fifties and sixties the Agricultural Economics Research Institute LEI created a form of accounting in which calculated costs for the unpaid labour of the farm-family and for the own capital of the farmer are incorporated in the profit- and loss account (Kuperus, 1970). Some results (like net-farm-profit and labour-income) were also calculated on a tenancy-basis, resulting in lower costs due to the regulated market for lease-hold properties. These methods were very useful for the costprice calculations and the comparison of results between regions, which the institute made and still makes in its reports on agricultural policy. Although these methods simplify comparisons between farms that differ in the use of family-labour and own capital, they also have some disadvantages if they play a prominent role in the accounting report for an individual farmer: understanding the high costs in which a remuneration claim for unpaid labour is included is not easy and a farmer does not take many decisions in which they play a role. Besides, a farmer who owns the land himself has to base his decisions on his own costs and not on the costs he would have being a tenant.

A similar remark can be made on the accounting reports produced by accounting offices. Due to their professional interests accountants tend to frame their reports to the methods and concepts of financial accounting. From the point of view of the
decision making farmer however, there is not only or even not in the first place an interest to justify themselves to the external world but all the more one for management-accounting. Where the industrial companies hire an accountant for a signature under their annual report, a farmer hires an accountant to realize efficiencies of scale by hiving off a business-function to a specialized firm. Therefore it would be better to focus the attention of accountants from the financial accounting-regulations to management-accounting tools like direct costing, calculating costprices, making budgets, linear programming etc. That conclusion is stressed by the conclusion of Johnson and Kaplan (1987) that even in industrial firms financial-accounting is over-developed compared to management-accounting.

1.5 Research-agenda

The information value of farm accounting can be improved. Two developments will influence this improvement: automation of the production process and the increasing importance of selected information for the farmer. Automation is a technology push factor: the costs of providing information quicker and in larger quantities decrease. A part of the data gathering (e.g. milk yields in the milking parlour, feed use in an automated concentrate server, payments by electronic banking circuits) is done at low cost by process computers. The increasing importance of information is a pull effect: research makes agriculture less dependent on nature. More and more the decisions farmers have to make are identified and the relationship between decision, necessary information and results is described. For instance in the Netherlands, the method 'Information Engineering' is used in all branches of agriculture to describe relationships between decisions and information requirements for farmers (see Davis and Olson (1984) for methods on determination of information requirements).

Some of the critical points which have been made until now can be handled relatively easy. Some suggestions:
* Accounting reports can be adapted to the bio-technical interests of the farmer by giving data per farm year, per production activity and by adding technical results like yields and other volume indicators.
* If other persons also play a role in the decision making, one could adapt a 'coalition-approach' and provide data on the division of net value added between the stakeholders.
* If maximisation of profits is not the only objective of the farmer, data can be provided on family-income, the increase in net-worth or opportunities for growth by or without leverage.
* Make clear which premises have been used in making the accounts and provide the relation between the calculated statistics and the decisions to be made by the farmer.
* Provide not only recent data (which are very much influenced by the natural circumstances of that year) but help to understand structural changes by calculating long term trends.
* Provide norms in order to facilitate the judgement.

In management information systems for farmers, the boundaries between accounting, planning and (technical) operational management will disappear. On family farms the size of the business nor the lack of separation of functions will stop this integration. To be able to function in that environment, farm-accounting will have to adapt, but is not immediately clear in which direction. It could be worthwhile if researchers would work on the following six topics, that are areas for a potential improvement of farm accounting.

- **Decision-oriented data and indicators**

Instead of providing the farmer with all possible data (some accounting-software easily prints pages or screens full of different data, not even in an alphabetic order, not to mention any usable classification) accounting has to satisfy the real information requirements. Information analyses can be helpful, although they are mostly rather normative and do not provide differences in importance of certain information or decisions. Indicators which are easy to understand and/or which have a leading character (e.g. based on Altman-type early warning systems) deserve special attention. That could mean that liquidity-indicators (like cash-flow) have partly to take over the role of profitability-indicators. Dethomas and Fredenberger (1985) concluded that one of the characteristics of small businesses is the more central role of cashflow.

Calculation of changes in productivity and of cost-prices (Johnson and Kaplan, 1987) could also be interesting. The investigation of variance under circumstances of risk (e.g. Scapens, 1983) has until now not been practiced in agriculture. It has to be noted that these remarks are all based on the notion that it makes sense to predict information requirements. However some authors throw doubt on this. Already in 1969 Sorter stated that the object of accounting developed from the value approach (which assumes implicitly that information needs are specified in advance) to the events approach (in which only events are recorded that can be valued and aggregated later on a users-request). March (1987) stated that decision theory is misleading for creating a management information system. In his view a good information strategy is not (!) "one that removes uncertainty from a prestructured array of decision alternatives connected to a predetermined array of preferences 'but more' one that moves the whole apparatus of information, desires and options in a productive direction, simultaneously developing ideas of what is 'productive' and instruments of achieving it". March makes a comparison with journalism: most of us are willing
to pay for their products that account of daily events
(newspapers etc.) to provide us with ideas and to entertain us,
but nonetheless most of the information generated by journalism
is gossip.

According to De Hoop et al. (1988), Dutch dairy farmers
expect information systems to give them a deeper understanding of
the aspects that play a role in a decision, the method of calcu­
lation and the direction of the outcome. The farmer must be able
to 'translate' the results towards his own farm, and often he has
a need to alter the calculation on the basis of his own
experience. A system has to stimulate the creativity of the far­
mers instead of dictating how to act, they concluded.

- **Planning**

The importance of the integration of planning and
accounting, with harmonized definitions of indicators has been
stressed already more than once in this paper. Planning includes
budgeting of technical and economical targets. For onfarm systems
especially tactical planning looks to be promising (De Hoop
et al., 1988).

- **Interim results**

Due to more controllable production processes and lower costs
providing interim results (e.g. on a quarterly basis) will become
more important. That means that the accounting concept partly has
to change from full-cost accounting to direct-accounting and more
cashflow indicators because it is hardly informative to calculate
the costs of depreciation every three months.

- **The premises of the accounting concept in relation to the
  objectives of the farmer**

Can the information value of the accounting report be
improved by changing from historic cost to current-cost-
accounting (Lewis and Jones, 1980), by disclosing capital gains
profit and loss account (in which all increases in net worth are
shown in the profit and loss account) could perhaps also improve
the understanding by farmers and make the problem of the profit-
concept more explicit.

- **Presentation of data**

It is not very clear how accounting data must be presented
in order to be easy understandable. Most accounting reports in
the Netherlands start with the profit and loss account or with
the balance sheet. Boehlje and Eidman (1984) start with the
income statement, which has the advantage that the transition
from cashflow to profit is shown explicitly. The presentation of
indicators can sometimes also be improved, e.g. by using a
Du-Pont chart like arrangement. And although several authors
(Jarett, 1983, Smith and Bain, 1987) looked to the possibilities
of using graphics and Davis (1982) stated that 'the lay-out of data has a significant influence on information use', it is until now not very clear which developments in the use of graphics are desirable.

Psychological aspects of presentation seem to play an important role in presentation and use of data (Davis, 1982, Tsversky and Kähneman, 1986, Van der Poel, 1987, Von der Ohe, 1985). Two biases seem particularly important: recency (humans are influenced more by recent events than by events of the past) and concreteness (decision makers tend to use only the available information in the form in which it is displayed. They tend not to search for data or transform or manipulate data that are presented).

- Typology of farmers

Nowadays accounting reports are to a small extent differentiated between farms, but a further differentiation is possible between (a) types of farming (because critical success factors differ or because the controllability of the production process differs), (b) the objective of the farmer (current-cost-accounting, which is used in the Netherlands, makes more sense for farms that will be succeeded than for older farmers without successor), and (c) the management profile of the farmer. Driver and Owona (1986) concluded in Canadian dairy farming that different management profiles exist, depending on know-how, farm results and risk aversion. The information-sources differed between the profiles. In Dutch horticulture, Alleblas (1988) developed, more or less comparable, 'management levels'.

1.6 Conclusion

Looking at the literature it is clear that farmers make only a marginal use of accounting. The production process of the organization of the industry provides some explanations for this situation. On the other hand farm accounting has been very much influenced by the concepts of financial accounting and policy research. Therefore some improvements can be made. For further improvements in the information value of accounting reports in a time characterized by automation and an increasing need for selected information, researchers will have to research more radical changes.
2. Determining farmers' financial information requirements

Abstract

Information models can be used to promote the adoption of information technology by farmers. This paper describes the development of an information model for all the financial decisions that are made by Dutch farmers. From the point of view of the farmer this is an especially attractive activity because other organisations in the agri-business complex dominate the information flows, which can lead to a lack of integration at farm level. The success of information analysis depends largely on the quality of the information analysts and on the interaction between interested organisations. Diffusion of the know-how of the information analysts to the stage of system design can be supported by the use of a workbench, but is nevertheless a critical test for this methodology.

2.1 Introduction

In Dutch farming, the development of information models is used to promote the adoption of information technology by farmers. This paper describes the development of an information model for all the financial decisions that are made by farmers. Theoretical aspects of the method and its place in software development are discussed. Organisational and practical aspects are also stressed. Some details of the model are given as an example, but due to the size of the model (235 processes and 110 entity-types) a complete presentation is impossible.

2.2 Strategies for information requirements determination

'An information system is complex and therefore needs an overall plan to guide its initial development and subsequent change' (Davis and Olson, 1984). This is also true in agriculture, which is dominated by small family farms. Compared with other industries these farms communicate relatively frequently with other organisations. In addition the degree of formality (e.g. in written reports, by record-keeping) of the information is rather low. These circumstances mean that agricultural software must convince the farmer that information handling is a profitable activity and not a waste of time. The swapping of data with suppliers, customers and especially advisors demands unambiguous definitions of the information, even without regard to the use of electronic data exchange. This is especially true if a
Figure 2.1 The stages of Information Engineering according to James Martin
growth path in the use of information technology is used and new software is first introduced by batch processing in central service.

Several methods for the building of information systems exist. Davis and Olson (1984) provide an overview: (1) asking, (2) deriving from existing systems, (3) analyzing the environment in which the system(s) will be used (e.g. by decision, - critical success factors - or process analysis) and (4) proto-typing. Applying their selection criteria (Davis and Olson, 1984:489) and having in mind the introduction of information technology in agriculture on a large scale, only the third strategy has a chance to be successful. In a situation where the use of information technology is nearly absent, asking (representative?) farmers or analyzing the first emerging systems creates a lot of uncertainties. Proto-typing can be very useful, but is expensive and works only on application-level. So, analyzing the decisions that are taken on the farm and the information that is used, will be the best strategy to promote the use of information technology on and round the farm.

Within this group of strategies, several formal methods exist, like Information Engineering, ISAC, NIAM, Critical Factor Analysis, Business Systems Planning and Systems Development Methodology. Differences between these methods are sometimes small. In this respect the use of a method is more important than the name of the method. In the Netherlands it was decided to use Information Engineering (IE) as a common method in determining the information requirements. The following sections describe the method and the organisational setting.

2.3 Information Engineering

The methodology of Information Engineering (Martin, 1982, 1986) is based on four principles. The first principle is that the development of management systems has to be based on a solid and stable foundation, so called architectures, in order to get mutual consistent systems, which use the same data. Four architectures can be noticed: the information-architecture (a description of the activities and data), the system architecture (a description of information systems and databases), the technical architecture (a description of hardware, communication networks etc.) and the organisational architecture (which describes the tasks for operation, maintenance, education etc.) The second principle is that data are a more stable element than processes and procedures which use the data. The third principle is laid down in the word 'engineering': it is a method with strictly defined steps, with a defined product or report for each step. The fourth principle is a top-down approach, starting from the business strategy planning of the organisation and ending with the use and maintenance of decision dedicated applications. The stages in this top-down approach are (figure 2.1):
1. **Information Strategy Planning** (a global description of activities and data from which 'clusters' are selected. On basis of the business strategy a priority ranking can be made for those clusters).

2. **Business Area Analysis** (a detailed analysis of activities and data for a cluster, resulting in a detailed process- and datamodel).

3. **Business System Design** (identifying possible systems; for such systems processes are mapped into procedures and the datamodel into datastores).

4. **Technical Design and Construction** (building applications and testing).

5. **Transition** (implementation and training of users).

6. **Production** (use and maintenance of the application).

In a larger organisation all these stages are completed within the firm. In Dutch agriculture the stages 1 and 2 are dealt with collectively by research institutes, experimental farms, the farm-accounting organisations and so-called branch organisations, in cooperation with software-makers, farmers and other interested parties. These branch organisations are founded per branch (type of farming) by the farmers' organisations to promote the use of information technology.

Results up to stage 2 are published as a result of public research. In principle next stages have to be carried out by the private sector: independent software-makers or accountants, farm-suppliers and cooperatives that provide farmers with programmes and information. That means that several different and competing applications can be built from the same information model. In such a situation the information from the applications would be comparable, but their user-interface could be as different as a pocket calculator from an integrated spreadsheet. In practice the branch organisations also operate some demonstration projects in which proto-types are built for the stages 3 to 5, in order to promote the use of innovative applications that are seen as too risky for the market. They also try to do some tuning in the field of communication networks like videotext and electronic data interchange, which are subjects of the technical architecture.

The information model that is developed in the stages 1 and 2 of Information Engineering can also be used to detect blind spots in our knowledge. If decisions are identified, but calculation rules can not be formulated, then research proposals can be formulated to transform unstructured decisions into structured ones. The creation of the financial information model also lead to a publication on possible research topics for accounting in agriculture (Poppe, 1988).

Education is another user of the information model. The decision-oriented approach makes an information model an attractive framework to organize seminars, courses and even text-books.
Data definitions and calculation rules that are harmonised in the information model are interesting subjects for education.

Information models are huge pieces of knowledge and of agreements that need consistency checking and maintenance. These activities can be supported by organisational procedures (see paragraph 2.10) and by specialized software, the so-called workbenches. A workbench is a software-package in which the information model can be written down in such a way that changes can be made relatively easy, that consistency checks can be made, that diagrams can be drawn and that documentation on revisions of the model (when and by whom?) is available. Results can be used in the further development of software, hence the name CASE-tool (CASE = Computer Added Software Engineering). In this project IEW (Information Engineering Workbench) from Knowledge Ware Inc. is used. Especially after the brainstorming-stages of a business area analysis have produced a more or less stable process model and data model, a workbench is useful in elaborating, checking and maintaining the model (Brand, Brinkkemper en Van der Steen, 1989).

2.4 Process model

In the first two stages of Information Engineering the process model and the data model play a central role. The process model describes all activities in the business that are related to information or decision making. The last addition makes sense: if we make an information model of moving cattle to another pasture, then essential processes are: deciding which cattle, deciding on which day, deciding by whom etc. But processes like driving cattle, opening the gate of the pasture and closing the gate would normally not qualify because these activities do not generate information. The total activity of moving cattle however can create the information that the cattle have been moved on that day. And if driving cattle can be done in several methods (e.g. by feet, by horse or by motorbike) and if the method will be evaluated later, than that activity is also an activity from an information point of view. The trick is to find the elementary processes, that are the smallest units of activity of meaning to a user as a decision-maker. The name of a process always contains a verb.

All processes of the business can be displayed in a process-decomposition-diagram, a structure which shows the breakdown of activities into progressively increasing detail. Elementary processes are the level with the highest detail; on a higher level there are functions, groups of business activities which together completely support one aspect of furthering the mission of the firm.

Figure 2.2 shows the process-decomposition-diagram for the financial and administrative decisions of the farmer. Functions
Figure 2.2 Process-decomposition-diagram
with production-oriented decisions like health care, roughage production, cattle replacement, etc. have not been worked out in our model; Information models for each type of farming have been made by the branch organisations.

The functions in the process decomposition diagram are grouped into three levels of decision making: strategic planning (longer term, creating capacity), tactical planning (medium term, mostly 1 year, planning the use of capacity) and the operational decisions (day-to-day planning and execution of decisions). This classification is based on Anthony (1965). A fourth level is added for bookkeeping, reporting and analysis, for which the term 'evaluation' has been introduced. In this way the classification of the functions represents the decision-process, which has a circular character, quite well.

Due to the size of the model (about 235 processes) not all elementary processes can be shown in figure 2.2. Annex 1 contains a list of the main processes. An example of the description of an elementary process is given in figure 2.3. It starts with a number and the name of the process. A definition and an explanation clarify the content of the process. In terms of elements of the datamodel (entity-types and attributes) the needed and produced information are given. In addition a process-description can also contain calculating rules and an estimation of the frequency of the process in the number of times per year the decision is taken.

2.5 Data model

The data model is at least as important as the process model. While procedures for decision making may change, data often stay the same. Central in a datamodel is the Entity-Relationship-Diagram (ERD). An entity is a fundamental thing of relevance to the decision maker, about which data could be kept. Entities can be tangible (a cow, a tractor), but can also be intangible events (a veterinary treatment) or abstract notions (a quality type of a delivery). A difference is made between an Entity and an Entity type, the latter being the collection of all the entities to which a specific definition and common properties (attributes and relationships, more details later on) apply. In a financial datamodel "Balance sheet" could be an entity type, and the fiscal balance sheet of the farm for 31. december 1988 an entity. In other words, an entity is an occurrence of an entity type.

Entity types can be described in terms of their relationships and their attributes. An ERD visualises the relationships between entity types, hence the name Entity type-Relationship-Diagram would be more correct. A relationship is a reason of relevance to the decision maker why entities from two entity types may be associated. Several kinds of relationships are distinguished:
Process: T.4.1.2.2 Checking received invoices

Definition: The checking of received invoices by comparing the agreed delivery or the executed delivery and with the agreed payment(s).

Comments: If the invoice is received after the actual delivery of the goods or services it should be compared with the data on the executed delivery. In that case the executed delivery is already compared with the agreed delivery. If the invoice has to be paid in advance of the delivery then a comparison with the agreed delivery should be made. In both cases the invoice should also be compared with the agreed payments. Depending on the outcome of these checking procedures the invoice will be accepted or disputed. The checking is carried out at the level of the invoice-lines but general conditions (eg. on the terms of credit) can also be disputed.

Data flows:

Incoming: INVOICE-DATA involves:

<table>
<thead>
<tr>
<th>Entity type</th>
<th>attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoice</td>
<td>201136 Invoice-reference number external person</td>
</tr>
<tr>
<td></td>
<td>201134 Invoice-date</td>
</tr>
<tr>
<td></td>
<td>201076 Own invoice-number</td>
</tr>
<tr>
<td></td>
<td>201048 Status accepted</td>
</tr>
<tr>
<td></td>
<td>201172 Percentage cash discount/penalty</td>
</tr>
<tr>
<td></td>
<td>201198 Circumscription</td>
</tr>
<tr>
<td></td>
<td>201202 Payment stipulations</td>
</tr>
<tr>
<td></td>
<td>201208 Date of receipt</td>
</tr>
<tr>
<td></td>
<td>201233 Type of invoice</td>
</tr>
<tr>
<td></td>
<td>201255 Currency</td>
</tr>
<tr>
<td></td>
<td>700154 Amount</td>
</tr>
<tr>
<td></td>
<td>700158 Total VAT</td>
</tr>
<tr>
<td></td>
<td>700326 Number of delivery notice</td>
</tr>
</tbody>
</table>

| Invoice-line  | 201137 Line number                                                         |
|               | 201060 Amount                                                              |
|               | 201126 Debit/Credit                                                       |
|               | 700165 Quantity                                                           |
|               | 700166 Unit                                                                |
|               | 700167 Circumscription                                                     |
|               | 201224 Price per unit                                                      |
|               | 700169 VAT amount                                                          |
|               | 201086 VAT type                                                            |
|               | 700171 VAT percentage                                                      |
|               | 700295 VAT mark                                                            |
|               | 201049 Status acceptation                                                  |

| Instalment    | 700297 Status paid                                                         |
|               | 700298 Period of payment                                                   |

| External person| 700072 Identification                                                      |

| Agreed payment | 700240 Period of payment                                                   |

| Contract       | 700010 Date of contract                                                   |
Figure 2.3 Example of a description of a process

In the workbench a difference is made between a description of a process (Definition, Comments and Dataflows) and a description of a dataflow (Name of the flow, Involves and a list of all the places where the flow occurs). According to the original methodology the two are combined in this example.
**Cardinality** describes how many entities may participate in the relationship. Forms are one-to-one (a worker can only have one labour-contract, but note that there can be 3 workers on the farm and therefore 3 labour contracts), one-to-many (an invoice can be paid by more than one payment, but a payment relates to only one invoice) and many-to-many (in a field-operation more machines can be used, and a machine can be used in more than one operation). These forms are also written as 1:1, 1:n, and n:m, and symbolized in an ERD by a 'caltrop', a split line.

**Optionality** describes if an entity of a given type always participates in a relationship. If this is not necessarily so, the relationship is called optional, which is symbolized in an ERD by a "0" at the end of the relationship. For example, the relationship between the entity types Cow and Veterinary treatment will be optional. In fact it will be an optional 1:n relationship because a certain cow will have been treated zero (so optional), once or many times.

**Exclusive relationships** can exist if an entity type has two or more relationships that exclude each other. For example Veterinary treatment can be given to a cow and to a pig (3 entity-types with two relationships) but as one treatment can only be given to a cow or (!) a pig, these relationships exclude each other.

Relationships can be described by short sentences that connect the entity types. In addition conditions can be formulated (eg. a budget consists of twelve periods, a cow can have at maximum 2 calves at a moment). Due to the size of the model (about 110 entity types) the total ERD can not be shown in figure 4.

An entity subtype is a collection of entities of the same type to which a narrower definition and additional attributes or relationships apply (eg. "fattening pig" can be an entity subtype of the entity type "pig").

An attribute is a descriptor, whose value is associated with individual entities of a specific type. Attributes of a tractor are its licence number, the brand, its acquisition cost, the book value, acquisition date etc. Attributes can be basic (eg. acquisition date), optional (eg. licence-number) or derived (eg. bookvalue). As derived attribute values can be calculated by the calculation rules of the process model, they are mostly excluded from the data model. Some basic attributes can be identifiers (or: key attributes) which mean that they can identify one and only one entity from all the other entities of the same type. If attributes are given an identifying number, that number can be used in data transmission to refer to that attribute definition.

An example of the description of an entity type is given in figure 2.5. The description starts with the name of the entity type. A definition and an explanation provide further clarification. The attributes, their character and the relationships complete the description. Figure 2.6 gives an example
Figure 2.4  Example of an entity-relationship-diagram
(All relationships between the involved entity types are shown, relationships with other entity types—like those between Invoice and External person—were omitted for lack of space)
Entity type: Invoice

Definition: Data on the obligation to pay or receive money for goods or services which are bought or sold.

Comments: The obligation to pay results from an agreed contract. Invoices can be split in incoming and outgoing invoices. In the information model both kinds of invoices are described with one entity-type, which has two relationships with External person/organisation: 'mailed by' for incoming invoices and 'received by' for outgoing invoices. These relationships are exclusive. In the agricultural sector nearly all the invoices are made by external organisations, which means that farmers have incoming invoices on their sales. Farmers seldom create invoices. Outgoing invoices are identified by an increasing number (attribute 'own invoice-number'). Incoming invoices are identified by the identification of the external organisation and their invoice-reference number. The attributes 'description reason cancelled' and 'cancelled amount' are to be used in situations where the farmer and the external person make a verbal agreement to change the invoice without making a credit-invoice.

Attributes:
- 201136 * Invoice-reference number external person
- 201134 Invoice-date
- 201076 Own invoice-number
- 201048 Status accepted
- 201172 Percentage cash discount / penalty
- 201198 Circumscription
- 201202 Payment stipulations
- 201208 Date of receipt
- 201233 Type of invoice
- 201255 Currency
- 700154 Amount
- 700158 Total VAT
- 700292 Cancelled amount
- 700293 Description reason cancelled
- 700324 Indication transfer
- 700325 Number of times dunned for payment
- 700326 Number of delivery notice
- 700333 Date transfer to collecting agency
- 700336 Planned instalment
- 700345 Date receipt dunning
- 700347 Last date of dunning
- 700356 Explanation solving dispute
- 700357 Credit invoice to be expected

* = key

Figure 2.5 Example of a description of an entity type
Relationships: INSTALMENT ex2 split from INVOICE
INVOICE contains INVOICE-LINE
INVOICE credited by INVOICE
INVOICE is credit-invoice of INVOICE
INVOICE is result of AGREED PAYMENT
INVOICE is split in INSTALMENT
INVOICE-LINE is part of INVOICE
AGREED PAYMENT is completed with INVOICE
EXTERNAL PERSON sends INVOICE
EXTERNAL PERSON receives INVOICE
INVOICE exl is send to EXTERNAL PERSON
INVOICE exl is send by EXTERNAL PERSON

Figure 2.5 continued

Attribute : 201134 Invoice-date
Definition : The date stated on the invoice as date of creation of the invoice
Format : -
Possible values: -
Domain : Date

Figure 2.6 Example of a description of an attribute

Domain: Date
Definition: The day that a certain action takes place, will take place or has taken place, recorded in a notation of the year, month and day (YYYYMMDD)
Comments: Uniform domain for all information models
Format: X(10)
Possible values: -

Figure 2.7 Example of a description of a domain
Figure 2.8 Example of a dataflow-diagram
of a description of an attribute: name, description, possible attribute values and sometimes a domain and its format are given. A domain is a meaningful collection of values from which the values of several attributes can be taken. Domains like date, time, address are used to guard descriptions, formats and possible attribute values of comparable attributes, like customer address, employee address, delivery address etc. Figure 2.7 gives an example of a domain description.

2.6 Integration of process model and data model

As process model and data model represent two views on the same decisions they must be well balanced. The dataflow diagrams (DFD's) are a first check. They show the dependency between processes. This dependency is shown as information views, which are flows of entities and attributes created in one process and used in another. Figure 2.8 gives an example of a dataflow diagram (or process dependency diagram). In addition to the processes also external objects are shown in a DFD. Those objects relate to organisations or data bases outside the farm that provide or receive information. Due to their comprehensibility DFD's can easily be used to discuss an information model.

A more formal way to check an information model is a create/use matrix. In such a matrix the processes are related to the attributes of the entity types. For each process, information is given on the use of all attributes: in the matrix a "c" (for create), "m" (for modify) or "u" (for use) indicates if and how an attribute is used in a process. A first technical check is that all attributes must be created somewhere and must at least be used once.

A workbench like IEW provides some additional methods for checking. An experienced information analyst has also some general rules to judge a model. He will look for redundant relationships and he will notice that a non optional 1:1 relationship often means that the two entity types can be joined into one, unless one of them is an entity subtype. Sometimes an n:m relationship must be replaced by a new entity type and two relationships because a decision maker wants to know something of that relation. For entity types that are used and "transformed" in different processes (like an invoice) a life cycle analysis can be interesting. It describes what can happen to an entity from the moment it becomes of interest to the farm till the time it ceases to be of interest.

2.7 Uniformity and bookkeeping

Uniformity of terminology is one of the main attractions of using information models. The definitions of entity types, their
attributes and domains, as well as the descriptions of processes and their calculating rules all help to create uniform information between decision makers and between the farmer and other organisations in the agri-business.

With respect to bookkeeping however this is not enough. In an information model of farm decisions, bookkeeping will be modelled in a few processes (eg. code payments as journal entries for the general ledger, value stocks on the closing date, make profit- and loss account) and in a few entity types (eg. payment, inventory, profit- and loss account, account-name).

Because the annual accounting report of the farm is used by the farmer, his accountant and tax advisor, his bank and his advisory service uniform directives are important. The use of (parts of) profits- and loss accounts in study circles of farmers and the publication of reference norms on costs and profits by experimental stations also favour the introduction of such directives.

Therefore, the Agricultural Economics Research Institute LEI and the Organisation of Agricultural Accounting Offices VLB published, in addition to the information model, a loose-leaf edition with a uniform scheme of account names (Chart of accounts) for the agricultural sector, under the Dutch acronym GRAS. It contains a scheme of account names and numbers, with uniform descriptions. In terms of the information model they can be seen as possible attribute values for the attributes of the entity type Account-name. It also contains lay-out models and calculating rules (eg. on depreciation) for the profit- and loss account, the balance sheet, the income statement and the flow of funds. In terms of the information model they can be regarded as calculating rules for the process Making annual accounts.

Included definitions of ratio's and key figures (eg. labour-unit, livestock units, solvability) can be seen as calculating rules for the process Calculate key figures, and as entities for such an entity type. Also included are valuation norms which can be used to value home produced feed or to value the inventory changes in livestock. These norms, which are updated every year, can be regarded as possible attribute values for the attributes of the entity type Valuation norm.

2.8 Model and reality

Davis and Olson [1984: 489] stated that every strategy for information requirements determination has its own uncertainties. In this section we look at the problems in applying IE in the way we did for Dutch agriculture. Some uncertainties have to do with the quality of the information analysts, the organisation they work with and the money they have available. Those aspects are dealt with in the next section. Here we focus on the method of IE which creates an information model, and - as one of my favourite
quotations states "a model is always less than reality, except a photo model, who is in fact more than reality". So it seems fair to mention the major discussions that were raised in the process of building this model for all the financial decisions that are made by farmers. In an arbitrary order:

* What does the representative farmer look like? A description of the decisions of all 130,000 Dutch farmers, or even of the top 10%, can hardly be realised in one information model. Even in financial decisions there are differences between farms in the same type of farming (e.g. is there a recording of stocks, are accounts payable and accounts receivable recorded, does paid labour occur, does the farmer create and send invoices or is that done by his cooperative or his customers?). In a reference information model such discussions can be solved by introducing additional optionalties, but that doesn't make the model any easier to handle. Developing several alternative models isn't attractive either.

* In addition to the first point there is the complexity of the family farm, especially when there are more entrepreneurs, as in a father-son partnership. Sometimes there exist in such a case only one cash-account but three or more separated forms of capital.

* Is an information model a model of everything that a farmer knows, or does it only describe the things he would be willing to record? Take for instance the entity type Contract which was introduced in the datamodel for important long-term contracts (like loans, futures etc.). From a legal point of view there is an implicit contract behind every financial transaction. The same reasoning can be applied to Inventory. Analysts that stress the methodological point of view according to which the incorporation of an entity or a process in a system (be it by hand or automated) rises only in the next stage of IE tend to incorporate such entity types and relationships. Others object for practical reasons. Beforehand it is not clear where the limits are. If an information model only describes the things which are nowadays recorded by farmers on paper, one could easily miss innovative aspects of information technology due to the introduction of sensors and connection of personal computers with dedicated machinery (e.g. climate computers).

* Another point of discussion is the modelling of decisions that are of infrequent occurrence, like choosing a legal form, handing over the farm to the next generation and some fiscal decisions. We choose to show these decisions as processes in relation to others in the process-decomposition diagram but not to work them out in detail for reasons of efficiency.

* Aspects of time play a minor role in IE. If one receives a delivery of concentrates first and the invoice a few weeks...
later, or just the other way around does not have much influence on the information model. But if a farmer wants to calculate his fodder costs on a week-to-week basis then data on invoices and supplementary payments by cooperatives at the end of the year will be missing. That brings in extra processes and data, e.g. estimating the compound feed price.

Where are the limits of the farm? Beforehand it is not certain that the farmers who use information technology will share out the same activities as their yesterday colleagues. At the moment nearly all farmers leave the bookkeeping activities to their accountant. So one could argue that processes as depreciating assets, calculating the profit and making the annual report could be omitted from the model.

The same argument applies to planning calculations on investments, which are often done by the advisory service. Omitting such decisions would not only lead to less uniformity in information shared by the farmer and his advisors, but one can also imagine that better software and training could bring such activities back to the farmer.

In addition to that point it looks reasonable to include entity types in the data model that have a clear function in the exchange of information between the farmer and other organisations. Some of these data, like a profit- and loss account or even a journal entry, are in terms of IE redundant information. All their attributes are derived ones that can be calculated as often as necessary. Because these entity types play such a central role in communication, and because their incorporation has an important positive influence on the communication value of the data model itself, accepting some redundancy here makes sense.

In practice some information in annual accounting reports and management systems seems not to be directly decision relevant in terms of a process model. Information analysts tend to classify such data as meaningless, but that can be misleading. Information analysis is based on the idea that it makes sense and that it is possible to predict information requirements. Some experts question that axiom. March (1988) pointed out that a lot of information is not directly meaningful to take decisions or to reduce uncertainty, but that it acts as background information and to stimulate the creation of ideas and alternatives.

We used the information model mostly as a normative approach to decision making by farmers. That does not necessarily mean that for instance investment decisions are in reality taken in a rational way, using a net present value concept as calculating rule. Another example is the calculation of cost-prices of arable products in a multi-product farm. Farm economists use gross margins and linear programming as a planning tool and are afraid that cost-prices based on full cost will lead to wrong decisions by farmers in the short
run. Farmers however ask software makers to extend their programs from gross margin calculations to cost-prices. For software development it is important to be aware of this limitations of using an information model. The advantages of using a model however outweigh these limitations because most of them only occur because one has to make a clear picture of the potential information users.

2.9 Organisational aspects

The determination of farmers' financial information requirements with the assistance of an information model has been carried out by the Agricultural Economics Research Institute LEI and the Organisation of Agricultural Accounting Offices. Technical information models were made by the branch organisations for every type of farming. In this section we discuss the organisational aspects of the co-ordination within and between such models.

The financial information model has been made between 1985 and 1990. Thirteen working groups published on detailed subjects. The first three groups reported on the first stages of Information Strategy Planning: an introduction on the aims of the project, a global datamodel and a global processmodel. These studies were used to create interest with potential participants and to identify clusters that could be worked out in detail in the next stage. In that second stage, eight business area analyses have been carried out: on paying/collecting, on drawing up an inventory, on invoices/accounts payable/accounts receivable, on bookkeeping, on planning cashflow, on strategic/tactical planning, on business analysis and on stock management/personnel management. In addition, two reports were written on the uniform scheme of account-names: one on the scheme of accountcodes itself and one on lay-out models for the report with the annual accounts.

The advantage of splitting up the work between several working groups is that it is much easier to recruit specialists from accounting offices. These people find it already difficult to co-operate intensively for some months; a longer period would mean that only junior members of the staff would be available. Another reason is that specialists on bookkeeping, planning, fiscal matters etcetera can be asked to co-operate on the moment their experience is needed. Another advantage is that more people share their knowledge with the project and distribute the results. A disadvantage is of course that in the end only the management of the project knows all the details. Besides the two project leaders, only two other persons were more or less directly involved in most of the activities throughout the whole project.
Only halfway the project it became clear that workbenches like the Information Engineering Workbench would be useful for consolidation and maintenance. Until that moment the consolidation of the different reports into one model was postponed. Although all working groups had not only published an information model but also extensive reports on the current knowledge with respect to the subject and had documented their choices, it has been a labour intensive activity to enter all the results in the workbench. This had to be done by persons who did not take part in all the working groups, and even a good documentation has to be read and to be digested.

The two reports on the uniform account-scheme have been worked up into the loose-leaf edition GRAS mentioned above. The eight reports on the information model will get the same treatment at the moment they are all stored in the workbench.

The working groups were all supported by a methodological expert of James Martin Associates and by a reference group in which senior experts represented the accounting offices, the advisory service, the Ministry of Agriculture, the faculty of economics of Wageningen University, the agricultural banks, the insurance companies, the organisation of agricultural software companies, the branch organisations and the experimental stations. A further co-ordination with the branch organisations, which will incorporate the financial information model into their technical model, took place in a working group with information analysts from this project and the branch organisations. They also dealt with a uniform application of the method and the workbench. This detailed co-ordination will make it possible to integrate the financial model in all branch models. That is efficient (otherwise the work should be done by 6 branch organisations) and it guarantees uniform definitions for mixed farms and for advisors working in different types of farming. In addition, all branch organisations had a working group on finance in which persons from this project collaborated with people from that sector in order to tackle specific financial subjects for that type of farming (e.g. calculating the value of livestock) and to integrate the financial and technical model.

On the whole 1) the working groups used fourteen man years (full time basis), excluding the commitment of persons in the reference group, the persons of branch organisations and James Martin Ass. About 75% of this time was used for making the information model itself, including coordination with the branch organisations, and 25% for the uniform scheme of accounts.

Measured in money at NLG 1000,- (USD 500,-) a day, which includes a fee for fixed costs like computers and buildings, and also for travel costs and material, the direct labour costs would

1) Estimation in June 1990 for the whole, nearly completed model.
have been 2.8 million. This was financed (directly in money and by paying two researchers with the LEI) by the INSF-plan for promoting Information Technology of the Ministry of Agriculture (75%), by the Organisation of Agricultural Accounting Offices (20%) and by the Agricultural Economics Research Institute LEI (5%).

2.10 From model to systems

An information model is an analysis of decisions and data within the farm and the relations with the environment of the farm in order to build an information system. The description of the method Information Engineering in section 3 already explained in general how a model can be used to create one or more systems. Here we look at the question in more detail, especially for the financial information model.

First of all it must be stressed that some results of our activities can be used directly in existing systems. The definitions of entity-types and attributes, calculation rules and of course the uniform account scheme can be implemented in existing software packages directly by the user or in new releases by the makers of the software. A few examples: several accounting offices already implemented the uniform account scheme and together with the information model itself it was used to discuss and solve differences in methodology between accounting practices and definitions used in planning software of the advisory service.

Beside co-ordination between software applications, the promotion of new applications is important. In the next stage of Information Engineering, called Business System Design, possible systems should be identified. That means first of all that a software maker has to identify product-market combinations. Considerations concerning interested types of farming, the number of farms, the level of knowledge that users have, the frequency of the decisions, and the product policy of the software maker will all influence the decision as to which systems will be developed. A matrix of processes versus existing systems can be very informative to analyse competing systems and to look for new market opportunities.

Also depending on the user knowledge that has been assumed, the degree of automation of the processes has to be established. Decisions that can be successfully automated tend to have the following characteristics: structured, frequent, demanding a lot of manual capacity, seen as problematic in present systems, able to communicate with existing automated systems, can be improved by using information technology, stable. Next, the processes can be mapped into procedures: a procedure is a method to execute one or more elementary processes. For one process, alternative procedures can exist, e.g. with different technics and/or at different places. An example: the process Calculate liquidity report can be
done at farm level by a manual procedure (using a pocket calculator), it can be done at farm level in a procedure using a PC, if desired in connection with a network to import data from the bank-account, and it can be done by the bank or an accountant and transferred on paper or over a data-network to the farmer. The system design also demands a description of a user dialogue and of administrative procedures that support the automated ones. The data model will have to be converted into a data structure, including data stores and applying the normalisation rules. Depending on the product/market combination that has been identified, the technical context of the system must be chosen, including communication standards and interfaces.

Until now the interim reports of the project have been more successful in the coordination of terminology in existing systems than in creating totally new applications. One reason may be the low number of personal computers in Dutch farming (table 2.1), which makes it risky for software makers to develop new integrated packages. They tend to improve existing systems that also have been successful as central batch processing services.

Beside the low number of personal computers in agriculture there are perhaps some other reasons for the - until now - imperfect fit between model building and system design. One of them is

| Type of farming | Number of farms | Pers. (mgt.) comp. | Video-tex users | Central service ***)
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable</td>
<td>6.570</td>
<td>600</td>
<td>1.085</td>
<td>0</td>
</tr>
<tr>
<td>Horticulture</td>
<td>11.680</td>
<td>1.250</td>
<td>3.430</td>
<td>725</td>
</tr>
<tr>
<td>Dairy</td>
<td>19.540</td>
<td>800</td>
<td>475</td>
<td>29.130</td>
</tr>
<tr>
<td>Pigs</td>
<td>3.580</td>
<td>1.400</td>
<td>30</td>
<td>6.200</td>
</tr>
<tr>
<td>Poultry</td>
<td>760</td>
<td>250</td>
<td>0</td>
<td>4.000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47.040</strong></td>
<td><strong>4.300</strong></td>
<td><strong>5.020</strong></td>
<td><strong>40.055</strong></td>
</tr>
</tbody>
</table>

*) Excluding mixed farms (which are however included in the total number of farms) and farms smaller than 50 Dutch size units, the size necessary to provide work for at least one person under efficient circumstances; **) More than one count per farm likely in arable and horticulture; *** Management information, excluding all forms of bookkeeping and annual accounting reports, which are obligatory for all enterprises by fiscal law. More than one count per farm occurs in dairy due to a large product range; The number of farms could be 10.000 - 15.000. The number of farms in intensive livestock includes many mixed farms. Source: 3CLO.
that the use of Information Engineering supposes that the method is used in all stages, from strategic planning to the maintenance of software. In practice, a lot of software makers use another method or no method at all to control their development activities. Several software makers, be it practical farmers or researchers in institutes or experimental stations, work alone or in very small teams without much formal training in software development. Their product policies tend to be a reaction to questions by users on their existing programmes or to research ideas. In the years to come, a further professionalisation of the industry, including a restructuring, is likely.

Another reason is that even with the help of a workbench like IEW and the publication of detailed research reports on the content of the model, it is difficult to transfer knowledge from the information analysts who build the model to the users. The co-ordination between the financial model and the technical models was handicapped by the same problem. A first reading and discussion of the financial model by the branch organisations did not lead to many reactions, but when a connection in a workbench had to be made much more detailed questions rose. In the same way it seems that ideas on possible systems which bubbled up in the process of making the information model are difficult to diffuse by publishing the model itself. A closer cooperation between persons who build the model and software makers could be helpful to stimulate the creative aspects of the system design.

The improvement of workbenches and other tools (like COBOL-generators), so that information models can be used directly to write programmes and create databases, certainly will mean a greater demand for information models, also in agriculture.

A last point to be mentioned is the maintenance of the model. Maintenance is necessary for several reasons. First of all, agricultural research creates new know-how, which makes parts of the model obsolete. New administrative procedures by the government (e.g. the introduction of set aside in arable farming) or by other organisations (e.g. the introduction of quality-marks of a product that will influence its price) have the same effect. In the coming years the financial information model, including the uniform account scheme, will be maintained by two groups of experts. It is however not expected that all costs of those maintenance efforts can be shared with the users of the know-how.

2.11 Conclusions

A further introduction of information technology in agriculture can only be successful if a careful analysis is made of the decision making process in which the farmer should use the software. Information modelling provides such an analysis. An
application from the point of view of the farmer is especially attractive because other organisations in the agri-business complex dominate the information flows, which can lead to a lack of integration at farm level. More uniformity in definitions is a big advantage of information models.

Information analysis is not a cheap activity, but it can lead to better and cheaper software: most mistakes in software development are made in this stage of analysis, and correcting those mistakes is, in addition, more expensive than de-bugging programming errors. The use of a workbench can lead to better models.

The success of information analysis depends largely on the quality of the information analysts (Davis and Olson, 1984: 489) as they have to decide what exactly will be included in the model and what will be left out. They decide in a way, what reality looks like. Project management is therefore important and discussions with potential users (in our situation among others the branch organisations) must be stimulated. Nevertheless it is sometimes difficult to diffuse the know-how of the information analysts to the stage of system design.
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Annex 1 List of processes in the financial information model

T.1 Strategic planning
T.1.1 Define goals
T.1.2 Determine prior conditions
T.1.3 Draw up a business plan
  T.1.3.1 Select products
  T.1.3.2 Calculate required land and quota
  T.1.3.3 Calculate required other fixed assets
  T.1.3.4 Calculate required labour
T.1.4 Calculate a business plan
  T.1.4.1 Make an investment plan
    T.1.4.1.1 Determine type of investment decision
    T.1.4.1.2 Analyse replacement
    T.1.4.1.3 Analyse investment project
    T.1.4.1.4 Make a complete investment plan
  T.1.4.2 Make a finance plan
    T.1.4.2.1 Calculate required funds
    T.1.4.2.2 Determine type of loan
    T.1.4.2.3 Determine required security
    T.1.4.2.4 Determine interest risk exposure
    T.1.4.2.5 Determine required insurances
  T.1.4.3 Select legal form and fiscal options
  T.1.4.4 Calculate budgeted accounts
T.1.5 Select a business plan
  T.1.5.1 Take advice
  T.1.5.2 Decide

T.2 Tactical planning
T.2.1 Define objectives
T.2.2 Determine prior conditions
T.2.3 Draw up variant technical plan
  T.2.3.1 Select varieties and periods
  T.2.3.2 Make a production plan
  T.2.3.3 Make a maintenance plan
  T.2.3.4 Make a labour plan
  T.2.3.4.1 Calculate required labour per period
  T.2.3.4.2 Determine available labour
  T.2.3.4.2.1 Grant holiday claims
  T.2.3.4.3 Balance available and required labour
T.2.4 Draw up variant financial plan
  T.2.4.1 Make a marketing plan
  T.2.4.2 Make a purchasing plan
  T.2.4.3 Time investment
  T.2.4.4 Make a tax plan
  T.2.4.5 Make a plan for family transactions
  T.2.4.6 Make a liquidity plan
  T.2.4.7 Calculate budgeted accounts
T.2.5 Select a tactical plan
  T.2.5.1 Take advice
  T.2.5.2 Decide

T.3 Operational management
T.3.1 Conclude a contract
  T.3.1.1 Call in a quotation and market orientation
  T.3.1.2 Make a quotation
  T.3.1.3 Weigh alternatives
  T.3.1.4 Conclude a contract
  T.3.1.4.1 Record agreed delivery
  T.3.1.4.2 Record agreed payment
  T.3.1.4.3 Record other agreed terms
  T.3.1.5 Control of contract
T.3.2 Control of stocks and services
  T.3.2.1 Control of production plan, marketing plan
    and purchasing plan
  T.3.2.2 Control arrival (incoming delivery) of goods
    and services
  T.3.2.3 Consume good or service
  T.3.2.4 Production of a good
  T.3.2.5 Control departure (outgoing delivery) of
    goods and services
  T.3.2.6 Take stock
    T.3.2.6.1 Record physical stock
    T.3.2.6.2 Determine quality
    T.3.2.7 Control stock differences
T.3.3 Control of fixed assets
  T.3.3.1 Delivery of fixed asset
  T.3.3.2 Use of fixed asset
  T.3.3.3 Maintain a fixed asset
  T.3.3.4 Put a fixed asset out of use
  T.3.3.5 Control departure of a fixed asset
T.3.4 Labour management
  T.3.4.1 Recruit personnel
    T.3.4.1.1 Select target group recruit process
    T.3.4.1.2 Select recruit channel
    T.3.4.1.3 Select a candidate
    T.3.4.1.4 Evaluate recruit process
    T.3.4.1.5 Conclude labour contract
    T.3.4.1.6 Maintain data employee
      T.3.4.1.6.1 Record data on schooling and training
      T.3.4.1.6.2 Record employee statement
      T.3.4.1.6.3 Record statement reduced Wage tax
      T.3.4.1.6.4 Record statement classification group
        Wage tax
      T.3.4.1.6.5 Record authorization for lower Wage tax rate
      T.3.4.1.7 Contract work out
      T.3.4.1.7.1 Contract out a task
    T.3.4.1.7.2 Contract a number of hours of work
T.3.4.2 Operational labour planning
T.3.4.2.1 Determine operations to be executed and the labour requirement per operation
T.3.4.2.2 Determine available employees
T.3.4.2.2.1 Grant holidays and floating days
T.3.4.2.2.2 Record announcement of illness
T.3.4.2.2.3 Record announcement of labour disability
T.3.4.2.2.4 Record announcement of work resumption
T.3.4.2.3 Make a weekly plan and provisional day plans
T.3.4.2.4 Arrange work at call
T.3.4.2.5 Make day plan and assign tasks to workers
T.3.4.3 Carry out labour and evaluate labour performance
T.3.4.3.1 Record data executed task
T.3.4.3.2 Record presence employee
T.3.4.3.3 Examine absence employee
T.3.4.3.4 Examine executed task
T.3.4.3.5 Examine skill of employee
T.3.4.3.6 Examine execution of contracted work
T.3.4.4 Calculation of wages
T.3.4.4.1 Record fixed data of employer
T.3.4.4.2 Record valuation data wage calculation
T.3.4.4.3 Calculate wage, holiday grants and cost reimbursements
T.3.4.4.3.1 Grant bonus payments and profit share
T.3.4.4.3.2 Grant cost reimbursement
T.3.4.4.3.3 Calculate wage
T.3.4.4.3.4 Calculate claim on holiday grant

T.4 Financial management
T.4.1 Control of invoices
T.4.1.1 Create outgoing invoice
T.4.1.2 Register incoming invoice
T.4.1.2.1 Receive incoming invoice
T.4.1.2.2 Check incoming invoice
T.4.1.3 Solve invoice problems
T.4.1.3.1 Solve problem outgoing invoice
T.4.1.3.2 Solve problem incoming invoice
T.4.1.3.3 Make pseudo credit-invoice
T.4.1.3.4 Clear incoming invoice and credit invoice
T.4.1.4 Control accounts receivable
T.4.1.4.1 Control invoice
T.4.1.4.2 Control debtor

T.4.2 Pay and collect
T.4.2.1 Pay per bank
T.4.2.1.1 Pay per payment order / cheque
T.4.2.1.2 Pay periodical per bank
T.4.2.1.3 Record and check bank payment
T.4.2.2 Pay in cash
T.4.2.3 Collect per bank or in cash
T.4.3 Control liquidity
   T.4.3.1 Record agreed instalment
   T.4.3.2 Estimate period of receipt
   T.4.3.3 Calculate optimal period of payment
   T.3.3.4 Control liquidity plan

T.4.4 Finance and invest
   T.4.4.1 Determine finance options
   T.4.4.2 Determine possible liberation of invested funds
   T.4.4.3 Determine investment options
   T.4.4.4 Select an alternative

T.5 Accounting
   T.5.1 Design accounting system
      T.5.1.1 Record units of the family farm household
      T.5.1.2 Select accounting report options
      T.5.1.3 Select method of stock registration
      T.5.1.4 Maintain accounting codes
      T.5.1.5 Maintain codesystem for inputs and outputs
      T.5.1.6 Set up valuation standards
      T.5.1.7 Maintain input-output coefficients
   T.5.2 Code financial transactions
      T.5.2.1 Record and code payment data
      T.5.2.2 Record inventories
      T.5.2.3 Record and code private transactions
         T.5.2.3.1 Record contribution of money, goods or services from the family household in the business
         T.5.2.3.2 Record use of business goods or services by the family household
      T.5.2.4 Record other periodical items
         T.5.2.4.1 Calculate and code depreciation
         T.5.2.4.2 Calculate and code revaluation
         T.5.2.4.3 Calculate and code calculated interest
         T.5.2.4.4 Calculate and code calculated rent
         T.5.2.4.5 Calculate and code calculated labour costs
   T.5.3 Complete general ledger
      T.5.3.1 Determine objects to be valued
      T.5.3.2 Fix balance sheet items
      T.5.3.2.1 Take stock of accounts payable / receivable
      T.5.3.2.2 Value field inventory
      T.5.3.2.3 Make corrections on entries
   T.5.4 Draft annual accounts
      T.5.4.1 Make and analyse liquidity report
      T.5.4.2 Make fiscal annual accounts
         T.5.4.2.1 Calculate fiscal balance sheet
         T.5.4.2.2 Calculate fiscal profit and loss account
         T.5.4.2.3 Calculate fiscal report fixed assets
         T.5.4.2.4 Calculate fiscal capital report
         T.5.4.2.5 Calculate fiscal flow of funds report
T.5.4.2.6 Calculate distribution of profit
T.5.4.3 Make commercial annual accounts
T.5.4.3.1 Calculate commercial balance sheet
T.5.4.3.2 Calculate commercial profit and loss account
T.5.4.3.3 Calculate commercial report fixed assets
T.5.4.3.4 Calculate commercial income statement
T.5.4.3.5 Calculate commercial capital report
T.5.4.3.6 Calculate commercial flow of funds report
T.5.5 Return fiscal declarations
T.5.5.1 Calculate declaration of VAT
T.5.5.2 Make report on WIR (Law on Investment Account)
T.5.5.3 Return declaration Income tax
T.5.5.3.1 Calculate Income tax and return declaration
T.5.5.3.2 Ask for taxing on 3-year average
T.5.5.4.3 Receive and check definite tax assessment
T.5.5.4 Return declaration Company tax
T.5.5.4.1 Return declaration Company tax
T.5.5.4.2 Return declaration Dividend tax
T.5.5.5 Return declaration Wealth tax
T.5.5.6 Calculate salaries and return declaration
Wage tax and Social Security premiums
T.5.5.7 Return other declarations and make
applications
T.5.6 Make other declarations
T.5.7 Make report on farm structure
T.6 Analyses
T.6.1 Calculate and analyse indicators
T.6.1.1 Make a sensitiveness analyses
T.6.1.2 Calculate indicators
T.6.1.3 Analyse indicators
T.6.2 Calculate and analyse results per product
T.6.2.1 Calculate gross margins
T.6.2.2 Calculate costprices
T.6.2.3 Analyse product results
T.6.3 Compare planning and realisation
T.6.4 Compare standards and realisation
T.6.4.1 Calculate normative results (standards)
T.6.4.2 Analyse comparison standards and realisation
T.6.5 Compare with earlier periods
T.6.6 Compare with other farms
T.6.6.1 Conclude contract for data exchange
T.6.6.2 Determine data to be compared
T.6.6.3 Determine farms to be compared
T.6.6.4 Receive data
T.6.6.5 Analyse report farm comparison
T.6.7 Diagnose strong and weak points