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How to define and study farmers' management capacity: theory and use in agricultural economics

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Abstract

Textbooks and articles on farm management stress the importance of the management capacity of the farmer with respect to his farm results. However, explicit definitions together with an elaboration of this concept are hard to find. In this article, aspects of management capacity are grouped into: (1) personal aspects, consisting of farmer's drives and motivations, farmer's abilities and capabilities and his biographical facts such as age and education; and (2) aspects of the decision-making process, consisting of practices and procedures with respect to planning, implementation and control of decisions at the farm. Empirical studies on the role of management capacity in relation to farm results are reviewed. Frontier production functions are widely used in recent literature to estimate technical and economic efficiency of farms. However, in explaining differences in efficiency most studies do not go further than adding a biographical variable (e.g., level of education). This study concludes that a next step would be to include aspects of the decision-making process. Longitudinal on-farm observations, which give possibilities for studying the dynamic aspects of the decision-making, are suggested to further analyze the concept of management capacity. © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Review study; Management capacity; Decision-making process; Frontier production function; Efficiency; Farm performance

1. Introduction

It is a well-established fact that economic performance can differ considerably between farms, even if they are operating under more or less similar production conditions. Differences in economic results are usually attributed to differences in the management of the farmer (e.g., Boehlje and Eidman, 1984). Management capacity can be seen as a separate, fourth factor of production, in addition to the traditional factors land, labour and capital (e.g., Case and Johnston, 1953). Then, what constitutes this special production factor? Despite many books and articles in the field of farm management and decision theory, the management process itself largely remains a black box, and management capacity is rarely explicitly defined and measured. The aim of this article is: (1) to give an overview of main aspects of management capacity; (2) to discuss the problems and opportunities with respect to measuring and collecting data of management capacity; (3) to review the empirical studies that relate management capacity to farm results; and (4) to detect weak spots and give suggestions for improvements.

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The outline of this article follows these four points. All sectors of agriculture are included, so farms and farmers also refer to greenhouses and growers. For the sake of readability, we write 'he' instead of 'he or she' when referring to a farmer or a manager in general.

2. Aspects of management capacity

Concise definitions such as "farm management is concerned with the decisions that affect the profitability of the farm business" (Castle et al., 1987: p. 3) or "using what you have to get what you want most" (Kadlec, 1985: p. 3) make clear that farm management is concerned with resources, decisions and results. Kay and Edwards (199): p. 7) list some phrases often used in definitions of management and show three common elements: (1) the need to establish goals; (2) the existence of resources to use in order to meet the goals; and (3) the possibility to use resources in alternative ways, varying in degree of effectiveness and efficiency, to produce several agricultural products. This description is rather broad and resembles common definitions of economics as a science that studies the ways in which finite amounts of resources are allocated to an infinite number of wishes.

A major part of any textbook on farm management is devoted to economic concepts and quantitative techniques for calculating optimal levels of inputs (resources) and outputs (products) under well-defined restrictions, i.e., managing resources in order to get the best results. A factor which may be overlooked when farm management is treated in a formal, more or less mathematical way is the role of the farm manager in the decision-making. His management capacity is the decisive factor when it comes to applying sound theoretic principles in practice. Johnson et al. (1961) described a large study where this problem is paid attention to: the Interstate Managerial Study. Objectives of this study were, for instance, to describe the role of information and decision-making. A survey was conducted among 1075 farm managers. This study was not the first on this subject, but due to its comprehensiveness it can be seen as a breakthrough in research on management in agriculture. Harling and Quail (1990) developed a simplified general management model, containing five elements:

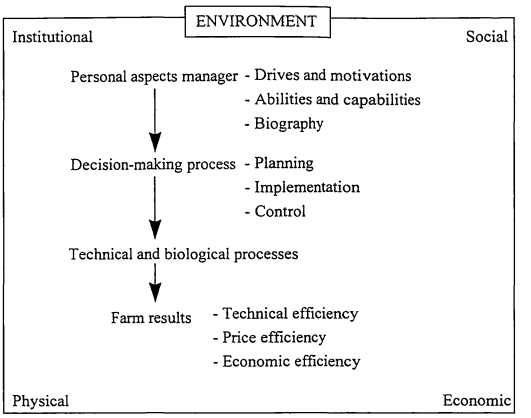

Fig. 1. Management capacities in relation to environment, biological processes and farm results.

strategy, environment, resources, managerial preferences and organization, which must be brought in balance.

Management capacity is defined here as having the appropriate personal characteristics and skills to deal with the right problems and opportunities in the right moment and in the right way. Starting point is the manager who has certain qualities. By means of his decision-making he will try to optimize (or at least influence) the technical and biological processes at the farm (see Fig. 1). These processes, controllable to only a certain extent, determine the technical and economic results of the farm. Stochastic elements, such as the weather, the incidence of pests and diseases and fluctuations in the market (prices) also play their part. Farm managers perform their task in an environment which changes over time in a hardly predictable way and therefore causes risk and uncertainty in the decision-making. Boehlje and Eidman (198): p. 670) distinguish four major dimensions: (1) the institutional environment (e.g., regulations on water, land and air pollution); (2) the social environment (e.g., the family of the farmer); (3) the physical environment (including the weather and the state of the technology); and (4) the economic environment (which determines prices of inputs and products).

Personal characteristics and skills, which are an important aspect of managerial capacity can be divided into: (1) drives and motivations, e.g., farmers' goals and risk attitude; (2) abilities and capabilities,

e.g., cognitive and intellectual skills; and (3) biography, e.g., background and experience (e.g., Muggen, 1969). Such personal characteristics and skills of the farmer are often assumed to be important in explaining differences with respect to the success of the farm.

A farmer who is confronted with favourable external conditions and who also has high personal skills—one might say favourable internal conditions—is likely to have good results. But still, it can go wrong when the decision-making process is poor. Following the steps of a well-defined process helps a decision maker to make a decision in a logical and organized manner and will on average lead to better results. Simon (1977) distinguishes four phases: intelligence, design, choice and review. Another well-known division of the decision-making process is: planning, implementation and control. Further subdividing the process lead Kay and Edwards (199): p. 13) to the following steps, assuming that goals (step 0) have already been established: (1) identify and define the problem; (2) collect data and information; (3) identify and analyze alternative solutions; (4) make the decision—select the best alternative; (5) implement the decision; (6) monitor and evaluate the results; and (7) accept the responsibility for the decision. Following such a process can help to (easily) explain and justify a decision, a criterion used for its quality by Slovic et al. (1977).

An important notion, in connection with the foregoing, is that in assessing the quality of a decision, one can use not only outcome-oriented criteria (the final results), but also process-oriented criteria. In other words, one can judge whether a decision is right before the outcome is apparent by looking at the process that led to the decision. Simon (1977) and Simon (198): p. 426) used the term procedural rationality. One hundred percent rationality is usually not realized or even wanted. Human decision-making can be characterized by impulsive responses, satisfying rather than optimizing behaviour and by bounded rationality rather than complete rationality. Summarizing this so-called model of bounded rationality (Simon, 1982): a decision maker is not likely to change, and make new decisions, unless a certain level of dissatisfaction about the current situation is reached. Then, in making a decision he is bounded by his limited cognitive skills, e.g., with respect to the amount of information that he can process. However, given these boundaries, he will try to act rational. He will use his skills and try to make reasonable—instead of optimal-decisions.

At every step of the decision-making process, part of the rationality can be lost. In order to be effective it is a basic condition that priorities are set and time is divided accordingly. Otherwise, the decision-maker might get entangled in smaller details of relatively unimportant decisions and forget to deal with the real important problems and opportunities (e.g., Covey, 1989). A manager can make an overview of the areas he should deal with and then choose which factors are most critical for being successful (Rockart, 1979). This can be called the *meta-decision*, deciding which decisions are most valuable to put an (intellectual) effort into, i.e., where and how to spend the time as a manager. Setting priorities and dividing time is an important aspect of the decision-making process. The choice of a number of critical processes, out of the complete picture of tasks, helps a farmer to concentrate on the right problems and to allocate his limited time in the right way. A complete picture of the farm could be made using fields of management (e.g., finance, production, personnel and marketing), functions of management (e.g., planning, implementation and control) and/or level of management (e.g., strategic, tactical and operational) as entries; see, e.g., Boehlje and Eidman (198): p. 15) who gave a list of major activities for each function of management. An example of an overview of the organization of the farm is the 'Dutch information model', that describes all functions, processes, information flows and data of the farm (De Hoop, 1988; Poppe, 1991).

3. Measuring management capacity

3.1. Personal aspects and decision-making processes

Some of the personal aspects (age, education, experience on the farm) of the farmer can be measured relatively well. Other personal aspects which lie in the area of drives and motivations, or abilities and capabilities are much harder to detect and quantify. They can be diverse, unclear and hidden. Hedges (196): p. 30) listed 19 of the more important traits and characteristics associated with capable management, such as willingness to learn, decisiveness and self-confi-

GROUP 1	**ANALYZING EXISTING FARM DATA**
1.	Primary source: written plans, calculations, calenders, records kept, etc.
2.	Secondary source: tax data, accounting data, etc.
GROUP 2	**SINGLE ON-FARM INVESTIGATIONS**
3.	Interviews
4.	Questionnaires
GROUP 3	**LONGITUDINAL ON-FARM OBSERVATIONS**
5.	Unstructured observations (participation)
6.	Structured observations
7.	Records kept by farmer on request (panel data)
GROUP 4	**OFF-FARM EXPERIMENTS**
8.	Tests
9.	Role-playing, gaming, simulation
10.	(Computer) experiments

Fig. 2. Forms of data collection to study management capacity of farmers.

dence. But, he remarks that, "we are not able to measure such a complex successfully, nor to evaluate its precise significance". Yet some progress has been made. A direct way to ask for drives and motivations was performed by Huirne et al. (1997). They asked farmers to point out the goals they had for their farms. They used several worksheets, consisting of open questions and closed questions and they also used small tasks.

Decision-making processes, as part of the management concept, are difficult to study in practice. Literature from the Business School shows how complex management can be. For instance, Mintzberg (197): pp. 10–11) cites two studies (Carlson, 1951; Davis, 1957) on managerial work in order to make clear that a manager is not working according to the classical functions of management, such as planning and controlling. A manager does not neatly divide his time in planning, implementing and controlling. This means that these concepts need to be translated into explicit, formalized actions and procedures that can be distinguished and measured. Such actions may be the frequency of consultants visiting the farm, the time spent on reading and processing farm results, or the time spent on meetings with personnel. Rather than measuring time and frequency of these actions, one could observe the (physical) results, showing evidence of a high quality with respect to planning and control. For instance, does the farmer have written plans—and if so, to what degree of detail and how far reaching in time—and how much does he know about facts and figures on his farm in relation to other farms? By distinguishing phases of the decision-making process and by defining explicit actions related to these phases, an opening is created to measure and quantify part of the management capacity.

3.2. Data collection

Several data sources can be used to study management capacity. Mintzberg (197): pp. 221–229) gives a review of methods used to gather data on managers. To study the management capacity of a farmer, being the executive of a small company, one can use either existing data or create new data. Several options are listed in Fig. 2. These options are grouped into four main categories: (1) analyzing existing farm data; (2) single on-farm investigations; (3) longitudinal on-farm observations; and (4) off-farm experiments.

Each data source has its advantages and disadvantages. The first group (1) of data sources makes use of already existing material, either produced by the farmer himself, as a primary source, or by others as

a secondary source. Also data can be used from existing study groups where farmers compare their results. A substantial advantage of these data sources are the low costs connected to them. A disadvantage is that they usually do not cover the research question completely. The data methods in group (2), interviews and questionnaires can be made up so that they entirely cover the research question and they can be performed at relatively low cost. However, one may question the reliability and accuracy of interviews and questionnaires: the respondent may have forgotten relevant details or deliberately give 'socially desired' answers or answers that avoid cognitive dissonance. Also, answers may be biased by the manager's perception of his own job (Mintzberg, 1973: p. 222).

Data sources (3) and (4) give more possibility for checking and for in-depth research, but are relatively expensive. Longitudinal on-farm observations (group 3) are based on repetitive data collection throughout a period of time. These observations are more expensive, but are more likely to generate more reliable and accurate data. Another advantage is that these methods are better compatible with decision-making processes, which are also continuous and dynamic by nature. The researcher will be visiting the farm on a regular basis to make observations and to ask questions (e.g., about his plans) and, in addition, the farmer may be requested to keep certain records during the intervals between the visits. A problem with this kind of studies is articulated by Dillon and Hardaker (199): p. 43) who wrote, "the mere presence of the observer can lead the person being studied to modify her or his behaviour".

Finally, in group (4), one can take the farmer away from his farm, take him to a 'laboratory', which can be a room equipped with computers, and study his management capacity through (personality) tests or (computer) experiments under controlled conditions. An example of this kind of research can be found in the work of Cross et al. (1994) who described workshops held with groups of farmers in order to investigate, among other things, the strengths and weaknesses of their information system.

In Section 4, empirical studies are reviewed with respect to the parts of management capacity they consider and the technique(s) they use for data collection and analysis.

4. Review of empirical studies

4.1. Methodology

This section focuses on empirical studies that explicitly deal with management capacity of farmers in relation to technical and/or financial results at the farm level. Empirical studies have been selected on the basis of the following criteria: (1) one or more aspects of management capacity of the farmer has been measured; (2) technical and/or financial results have been measured; (3) a relationship between management capacity and results has been analyzed; and (4) the research has been published in scientific agricultural economics and related English-language journals in 1980 or later. Table 1 gives an overview of studies that meet these criteria.

The variables analyzed are investigated and compared with the aspects in Fig. 1 (see Section 2). Besides these variables measuring management capacity, Table 1 contains farm results. Studies are divided into those using the production frontier approach and those using other approaches. Battese (1992) reviews the methods that can be used to estimate the production frontier: deterministic frontiers, stochastic frontiers and panel data models. The current study is focusing on types of efficiency that can be measured. The production frontier approach distinguishes technical efficiency (TE), price efficiency (PE) (also called allocative efficiency), and economic efficiency (EE). Technical efficiency is the ability to avoid waste by producing as much output as input usage allows, or by using as little input as output production allows. Price efficiency is the ability to combine inputs and outputs in optimal proportions in light of prevailing prices (Fried et al., 1993). Economic efficiency is a measure of overall performance and is equal to technical efficiency times price efficiency (i.e., EE=TE*PE) (Bravo-Ureta and Pinheiro, 1993). The studies which do not use the production frontier approach use straightforward technical results (T) or financial results (F). In total, 23 studies will be discussed here, of which the majority is dealing with dairy farming, but also crop, greenhouse, swine and mixed farming are dealt with. First, the methods and techniques used to measure farm results will be discussed. After that the methods to study management capacity will be worked out.

Table 1
Variables describing management capacity included in empirical studies

	Management Capacity[a]		Results[b]	No. of farms included
	Personal aspects	Decision-making		
Production frontier approach				
Moock (1981)	B	P	TE	152
Jamison and Moock (1984)	B,A	P	TE	683
Kalirajan and Shand (1985)	B,A	P,C	TE	91
Stefanou and Saxena (1988)	B	–	PE	131
Ali and Flinn (1989)	B	–	EE	120
Bravo-Ureta and Rieger (1991)	B	P	EE	511
Kumbhakar and Heshmati (1995)	B	–	TE	250/430
Parikh et al. (1995)	B	–	EE	436
Adesina and Djato (1996)	B	P	EE	410
Battese et al. (1996)	B	–	TE	499
Wang et al. (1996a, b)	B	–	EE	786/1889
Other approaches				
Achten et al. (1983)	B,D	P,C	F	71
Goodger et al. (1984), Goodger and Kushman (1984–1985), Goodger et al. (1988)	B,D,A	P,C	T	20/50
Bigras-Poulin et al. (1984–1985a, 1984–1985b)	B,D,A	C	T	110
Sharma and Patel (1988)	B	–	T	176
Cowen et al. (1989)	–	P,C	T	218
Jofre-Giraudo et al. (1990)	–	P,C	F	50
Rosenberg and Cowen (1990)	–	P,C	T	87
Tarabla and Dodd (1990)	B,D	C	T	123
Jose and Crumly (1993)	A	–	F	120
Hurnik et al. (1994a, b)	B,D	–	T	69
Kiernan and Heinrichs (1994)	–	C	T	329
Dewey et al. (1995)	D	C	T	76

[a]B=biography; D=drives and motivations; A=abilities and capabilities; P=planning; I=implementation; and C=control.
[b]TE=technical efficiency; PE=price efficiency (=allocative efficiency); EE=economic efficiency; F=financial parameter; T=technical parameter.

Management capacity in these empirical studies has been related to the farm results. What variables are used as indicator(s) for farm results? In Table 1 it can be found that nine studies compare management capacity with financial farm results (indicated by F, PE or EE in Table 1). Especially in the latest years, the production frontier approach has been used more and more to determine farm results. Stefanou and Saxena (1988) calculated the price, or allocative, efficiency. Ali and Flinn (1989), Parikh et al. (1995), Bravo-Ureta and Rieger (1991), Adesina and Djato (1996) and Wang et al. (1996a, b) calculated the economic efficiency. In other studies plain financial parameters are used as an indicator for farm results. Achten et al. (1983) used the money value of the real yield in horticulture. Jofre-Giraudo et al. (1990) evaluated the influence of management capacity on economic benefit, however, in a subjective way. The manager is asked whether or not the benefits of their management changes had compensated the costs. Jose and Crumly (1993) used several debt and income indicators. Other studies focus on technical aspects only, for instance milk production (Sharma and Patel, 1988; Tarabla and Dodd, 1990), or respiratory disease in swine (Hurnik et al., 1994a, b). Some studies relate the management capacity to more than one technical parameter (Goodger et al., 1984; Goodger and Kushman, 1984–1985; Goodger et al., 1988; Bigras-Poulin et al., 1984–1985b; Cowen et al., 1989; Rosenberg and Cowen, 1990), ranging from the number of repeat breeders to somatic cell count (as an indicator for quality of milk), disease rates and culling rate. Overall, it can be concluded that all kinds of different methods are used as an indicator for farm results. The studies which use the economic efficiency criteria, are the only ones that (can) combine technical and economic results.

Although many different methods to measure management capacity are available (see Fig. 2) it turns out that in practice, single on-farm observations are most frequently used. Kumbhakar and Heshmati (1995), Ali and Flinn (1989), Battese et al. (1996) and Wang et al. (1996a, b) used panel data. However, these data lack information on the decision-making process: only the farm results over time are measured. Longitudinal on-farm observations are likely to generate more reliable and accurate data. However, they are more expensive and time-consuming.

Almost all studies use questionnaires or interviews except for Goodger et al. (1984, 1988), Goodger and Kushman (1984–1985). They make observations and perform measurements on the farm. This method of research is much more time consuming, as reflected in the number of farms included in the research: Goodger and Kushman (1984–1985) used 20 farms. The only off-farm experiment in which the relation between management capacity and farm results was measured is found in Jose and Crumly (1993), who used a psychological test.

4.2. Personal aspects

Quite some work has been done on the relationship between education and farm efficiency. From different studies it can be concluded that education has a positive influence on farm results, especially in developing countries. Lockheed et al. (1980), Bravo-Ureta and Pinheiro (1993), and Phillips (1994) reviewed papers that measure the effect of a farmer's educational level and exposure to extension services on his productivity. They focused on studies performed in low-income regions. Overall, they found confirmation for the hypothesis that education, as a part of the farmers' biography, will have a positive effect on farmers' efficiency. Other studies (see Table 1) also indicated that education is positively correlated with farm results (Moock, 1981; Achten et al., 1983; Jamison and Moock, 1984; Bigras-Poulin et al., 1984–1985b; Stefanou and Saxena, 1988; Ali and Flinn, 1989; Parikh et al., 1995; Battese et al., 1996; Wang et al., 1996a, b). However, no significant effect of education on farm results was found by Kalirajan and Shand (1985), Tarabla and Dodd (1990), Adesina and Djato (1996).

Another personal aspect quite often looked at, is the experience and/or the age of the farmer. The influence on farm results is not straightforward. Some studies found a positive effect of experience (Kalirajan and Shand, 1985; Stefanou and Saxena, 1988), while others did not find any effect at all (Sharma and Patel, 1988; Hurnik et al., 1994a, b). A negative influence of age on farm results was found by Parikh et al. (1995), but no effect by Jamison and Moock (1984), Tarabla and Dodd (1990). Battese et al. (1996) found effects of age on technical efficiency. However, the direction of the effect differs between districts of Pakistan.

Bravo-Ureta and Rieger (1991) found opposite effects of age (also called experience) on TE, PE and EE. To summarize, biographical aspects can affect farm results, technically as well as financially, but the results are diffuse; sometimes an effect is found, sometimes it is not.

Drives and motivations that are investigated vary from goals of the farmer, attitude towards paperwork, openness to new ideas, level of ambition, satisfaction with farming, to most preferred job at the farm. Milk yield and fat yield are positively correlated with level of ambition (Bigras-Poulin et al., 1984–1985b). Satisfaction with farming is usually found not to be of any influence on farm results (Tarabla and Dodd, 1990; Hurnik et al., 1994a, b), only Bigras-Poulin et al. (1984–1985b) found an influence of satisfaction with farming on farm results, in terms of rate of culling and fat and milk yield. Dewey et al. (1995) found that litter size can be influenced by the most preferred job of the farmer. Almost all these studies show that farm results are dependent upon some aspects of drives and motivations of the farmer, but these aspects and the resulting effects are measured in a lot of different ways, which complicates the making of comparisons.

Table 1 indicates that ability and capability variables (as part of the personal aspects of the farmer) are rarely analyzed. Besides that, these variables are diverse, making it difficult to draw an overall conclusion on their effect on farm results. Variables mentioned in the studies vary from knowledge of cow behaviour, knowledge of technical recommendations and prices, understanding of technology, to assertiveness and temperament. No influence of level of assertiveness on farm results was found (Bigras-Poulin et al., 1984–1985b). Goodger et al. (1984), Goodger and Kushman (1984–1985) calculated an overall management index. They put the same weight on all kind of aspects, to calculate an overall score. Knowledge of cow behaviour is one aspect of this index. They found a positive relation between the overall management index and farm results, but the separate effect of knowledge has not been determined. Understanding of technology, measured by asking the farmer to describe the different recommendations of new technologies, was found to have a significant (positive) effect on the yield of rice (Kalirajan and Shand, 1985). Jamison and Moock (1984) measured numeracy, literacy and an agricultural knowledge test score. These aspects were taken as variables in different production function regressions. Sometimes a positive effect is found on production, sometimes no effect could be determined. Jose and Crumly (1993) compared the temperament factors with financial measurements. They found that 'thinking people' have higher total assets than 'feeling people', and 'extrovert people' have higher debts than 'introvert people'. From this small overview on relations between abilities and capabilities of the farmer and farm results, it can be concluded that the knowledge in this area is still rather limited in agricultural literature. It can be concluded that the influence of education is often studied, while other personal aspects are under-exposed.

4.3. Decision-making processes

With respect to decision-making, a distinction is made between planning (P), implementation (I) and control (C). Studies on planning can be divided into two groups. The first group measures aspects of the decision-making process itself (e.g., the length of the planning horizon and the degree of detail), the other group focuses on aids that are used for the decision-making (e.g., use of computer records, extension services, and other information processing devices). Studies looking at the decision-making process itself usually find a positive effect of planning on farm results. The variables used, however, are very diffuse. Achten et al. (1983) investigated to what degree of detail plans are made, concerning production, labour requirement, etcetera. Planning of short-term decisions and activities proved to be an important factor which influences the yield level of greenhouse vegetable producers. Decision-making procedures in staff matters were investigated by Goodger et al. (1984), Goodger and Kushman (1984–1985) as an indicator of management effectiveness. A judgement on the quality of the decision-making process of the farmer was made during an open interview on how the farmer makes his decisions. They found a positive relationship between an overall management score (the decision-making process being a part of it) and milk yield, days in milk, and days open. Cowen et al. (1989) investigated the effect of data processing devices: whether the farmer made use of computer records,

or lists of things to do (e.g., cows to breed). They found that use of computer records or lists of things to do results in observation of problems in an earlier stage. Rosenberg and Cowen (1990) determined the level of rationality in the decision-making process of the farmer, by asking the farmer to describe the process (e.g., how milkers were chosen). They did not find a relation with farm results.

Studies focusing on aids that are used for decision-making are mostly focusing on the use of external advisors. Jofre-Giraudo et al. (1990) are the only ones who measured other aspects as well. They investigated what sources of information for planning purposes are used (e.g., records from the dairy herd improvement association (DHIA), own herd records, etc.). However, the collected data were not sufficient to relate this to the results of the farm. The findings with respect to the influence of external advisors is mixed for the different kinds of efficiency. Adesina and Djato (1996) did not find a significant influence of extension on economic efficiency. Moock (1981), Kalirajan and Shand (1985), found a positive effect of the number of extension visits, as a source of information, on technical efficiency. Bravo-Ureta and Rieger (1991) found an effect of extension on efficiency. However, the effect on technical efficiency is positive, but the effect on price efficiency and economic efficiency is negative. This shows that focusing on technical efficiency alone may have a negative influence on the overall economic efficiency. The risk of producing beyond the optimal economic level of production is present.

None of the studies reported findings on the quality of the implementation of decisions. However, implementation is closely related to time allocation: how is a farmer using his time? Time allocation, is included in five studies and, again, the elaboration of it is rather heterogeneous. Time allocation variables vary from the time available for cleaning, time spent at keeping health records, time spent on heat detection, time spent on management and hours of continuing education, to regularity of communication with milkers about job performance. Time spent at keeping health records turns out to decrease the incidence of reproductive disorders (Bigras-Poulin et al., 1984–1985b). Regularity of communication with milkers about their job performance has a positive influence on milk yield (Rosenberg and Cowen, 1990). Dewey et al. (1995) found a positive effect of the time spent on heat detection and breeding on the average litter size. They also asked farmers whether or not they spent enough time on insemination of sows and heat detection. Here, no relationship was found with the farm results. Jofre-Giraudo et al. (1990) asked farmers to estimate the time they spent on management. Farmers with an information system spent more time on management than farmers without. However, no clear relation was found with the financial results of the farm. Although different studies focused on time allocation of the farmer, none of the studies measured the complete distribution of time of the farmer over all kinds of different activities. This would be interesting and clarifying, yet difficult to carry out.

Studies focusing on the control part of the decision-making process are divided into two groups: studies focusing on aspects of the decision-making itself (e.g., criteria used for evaluation of farm results), and studies that investigate side-line aspects. The use of information—as a side-line aspect—seems to have a positive effect on the results. Cowen et al. (1989), Kiernan and Heinrichs (1994) investigated whether or not external data are used as a source of information. Both found a positive influence of using this external data on farm results. Jofre-Giraudo et al. (1990) also investigated the use of external data, but did not relate this to farm results. Tarabla and Dodd (1990) found that the number of times the milking machine is tested per year is positively correlated with the quality of milk. Rosenberg and Cowen (1990) found that use of written records in the herd decision-making, has a positive influence on the quality of milk, the average days open and leads to a smaller number of services per conception. They also had a look at the decision-making process itself: the criteria used in the evaluation of farm results were studied. The hypothesis was that the objective criteria combined with regular communication with milkers about their job performance would lead to higher results. But they did not find support for this hypothesis. Both aspects did not seem to influence the farm results. So, no study was found where an effect of the quality of the control itself—as part of the decision-making process—on the farm result could be determined.

To summarize the above, two observations can be made. First, studies which use the production frontier approach usually look at age/experience and educa-

tion of the farmer and to the use of extension services (as part of the planning), yet ignore other personal aspects of the farmer and his decision-making process. Other studies take into account more aspects, but none includes all aspects of management capacity (B, D, A, P, I and C; see Table 1). Second, when an aspect is taken into account, the elaboration of it differs greatly between studies, leading to a wide range of variables measured.

5. Discussion and conclusions

This article reviewed empirical studies that relate farm results to management variables. First, the concept of management capacity was elaborated. Management capacity was defined as having the appropriate personal characteristics and skills (including drives and motivations, abilities and capabilities and biography), to deal with the right problems and opportunities in the right moment and in the right way. The way problems and opportunities are dealt with by the farmer/manager is reflected in the decision-making processes (split into planning, implementation and control), meant to influence the technical and biological processes on the farm, which in turn determines the farm results. Each of these steps can be controlled only partly, stochastic elements from the environment also play their part.

Empirical studies show an influence of management capacity on farm results. For instance, Jose and Crumly (1993) who found a relation between personal characteristics and economic results. Overall, the proportion of variance in the dependent (result) variables that is explained by the independent (management) variables differs from 7 to 40% between the studies reviewed. However, these values are hard to compare, due to differences in the way management capacity is defined in these studies, differences in independent variables that are included, and differences in definition of farm results.

Recent studies frequently used the production frontier approach to estimate technical and/or economic efficiency at farms. Elements of management capacity can be added to the list independent variables in this approach. Most often education and experience are taken into account. The method has met critique on the applicability of the rules of neoclassical economics to traditional agriculture (e.g., Torkamani and Hardaker, 1996). Furthermore, for the purpose of relating farm results to management capacity, the production frontier approach must be compared to other methods. The path model approach, for instance, gives the opportunity to set up a stepwise analysis, as shown in Fig. 1 (where personal aspects influence the decision-making process, which, in turn, influences the farm results). So, whether to use the production frontier approach or an alternative approach, needs attention on forehand, taking into account the pros and cons of the different alternative methodologies.

Most empirical studies on management capacity of farmers, in relation to farm results, use questionnaires and interviews for data collection. These are usually executed without repetition, leading to single measurements. To effectively analyze the role of all aspects of management capacity, other methods can be useful. On-farm investigations, with regular repetition, are more appropriate to study management capacity of farmers. Such longitudinal observations are more in line with the dynamic nature of decision-making processes. Also, they give opportunities for verification and are, therefore, likely to give a more realistic picture. Off-farm experiments with farmers, e.g., in a computer laboratory, can be used to simulate decision-making processes, to assess certain abilities and capabilities of the farmers and to find out about their drives and motivations and their attitude toward risk. However, there is considerable evidence to suggest that the external validity of decision-making research that relies on laboratory simulations of real-world decision problems is low (Ungson and Braunstein, 1982: p. 39). To provide evidence on validity of different methods, the need for multimethod approaches is generally acknowledged.

The last objective of this study was to detect weak spots and to give suggestions for improvements for studying management capacity in relation to farm results. It can be concluded that the decision-making process is under-exposed. This is especially the case for the studies using the production frontier approach. The decision-making process can only be measured by longitudinal data, for instance, structured farm observations/visits in time, to follow the planning, implementation and control on the farm. This kind of studies can lead to a better understanding of differences in

success between farmers and can serve as a basis for support and improvement of their farm results.

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