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Role of veterinary management in increasing pig breeding efficiency: a methodological approach

The aim of this research was to determine the effects of different factors of production (farm management strategy, veterinary management, physical farm conditions, and breeding technology) on the performance of Hungarian pig breeding farms. Performance is defined in a broad sense, reflecting the complexity of pig breeding, taking into consideration technological and economic indices. According to our hypothesis a direct, quantifiable stochastic relation can be shown between management strategy, veterinary practice management, construction and building engineering characteristics of plants, breeding technology and the performance of farms. The data for the analysis were acquired by a direct question survey of more than 130 Hungarian pig breeding farms. Utilising these data, different indices were created for each farm with the purpose of information compression. Based on these indicators, a series of linear regression equations was set up to describe the relationship between independent (exogenous) variables, such as management strategy, intervening causal variables (such as the piglet rearing technology and veterinary practice management) and the performance, as the dependent variable. This simultaneous equation model was tested using Mplus® software. The results serve as quantitative, statistical evidence for the effect of management practice in general, and veterinary management in particular, on the performance of pig breeding farms. This can be considered as clear proof of the economic importance of veterinary management.

Keywords: performance, swine, veterinary management, structural equation systems

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Introduction

After the collapse of the former social, economic and market system the structure of Hungarian pig production changed considerably. The share of co-operative farms declined drastically while there was a rapid increase in the number of private agricultural enterprises. During this time the efficiency of production sharply declined, but after the years of transition, the smallest producers quitted production. As a consequence of adverse socio-economic conditions in the pig sector (a decrease in domestic pork meat consumption, a drop in export quantity and prices, and disparity between the input and output prices of swine farms) the number of pigs in Hungary sharply decreased. There is also a trend towards equalisation of the pig prices between Hungary and other European Union (EU) Member States (MS). This represents a new threat for the Hungarian pig production sector because the opportunity for increasing prices without decreasing the market share is rather limited. The competitiveness of Hungarian pig breeding compared to other countries with important pig sectors can be considered as extremely poor (Rasmussen, 2006; Hoste, 2011).

In such countries, where the laws of the market economy have been dominant during the last half century, the methodical analysis for pig breeding technology and veterinary medicine has strong traditions. For example, in England there are extensive databases for the assessment of benchmarking (comparative analysis) of different farms from the point of view of different technological and veterinary indices (Robertson *et al*., 1991; Ridgeon, 1993; Enting *et al*., 2000). There are numerous analyses dealing with the effect of elements of technology or veterinary practice on performance of farms but a review of the literature did not find models which analyse the interdependence of factors influencing the performance of pig breeding units. In the EU New MS, which have undergone a fundamental paradigm change, the economic quantification of effects of different technological and veterinary factors is even more difficult due to the lack of reliable statistical data and long term time series.

In these countries (e.g. in Hungary) the new owners of pig breeding farms often lack professional knowledge, experience and finance (Balogh *et al*. 2009). As a consequence, they try to decrease their production costs by minimising the cost of pharmaceutical preparations and in some cases do not recognise the role of veterinary medicine in improving performance in pig breeding enterprises. A good example for this short-sighted approach is that while in Hungary the production cost is practically the same, the proportion of animal health costs is only one third or half of that in other MS (e.g. Lara *et al*., 2002; Béládi and Kertész, 2006).

The aim of this article is to determine the basic interdependences between farm management strategy, technology, veterinary practice and performance of swine herds. The concept of 'strategy' has many references in international management science. Porter (1985) showed that the firms can compete with each other by three strategies: minimising costs (cost-leadership), differentiation, or focusing on a well-defined market segment. As Török (1994) has demonstrated, this grouping is only partially applicable in a post-transition economy because the 'drifting' of managers and firms is also a general trend. In the case of agricultural enterprises the same trend has been illustrated by Kapronczai *et al*. (2005). From the point of view of the long term development of pig producing enterprises the commitment of management to quality oriented development plays a key role, but under the pressure of current financial and organisational problems, or due to a lack of qualifications, as well as the short-sightedness of managers, this approach is often pushed into the background.

The importance of defining the concept of performance is widely recognised but its treatment in research findings is perhaps one of the thorniest issues confronting strategy researchers today. Most earlier studies on strategy have

described performance in terms of profitability, either alone or together with other performance indices (Venkatramand and Ramanujan, 1986). Since profitability is influenced by the external economic and social environment, as well as many previous time frames, it is unlikely to be a complete reflection of current advantage. Under these conditions, given that performance is not a unitary concept, considering only profitability as a measure of performance is inadequate. In this study the performance was analysed in a multidimensional matrix consisting of technological indices, net profitability in the last seven years and the rate of change in turnover.

Methodology

The form of our questionnaire, which aimed to show the position and strategy of Hungarian pig producers, was determined on the basis of three focus groups with experts working in pig farm management. In the second phase, a pilot study was conducted to test the questionnaire. For practical reasons the original questionnaire was divided into three parts: the general, comprehensive questionnaire inquiring after the main strategic directions of the farms, which was sent to the farm managers together with another questionnaire analysing the breeding technology, environmental management and the housing problems of the units. A questionnaire specifically concerning the animal health management and animal welfare status of the farm was sent to the veterinary specialist. The survey of veterinary practice management, physical condition of buildings, breeding technology and animal health status was based on the principles and suggestions of the literature (Kovács, 1990; Rafai, 1996; Deen *et al*., 2001).

After some improvements based on the results of the pilot study, the questionnaire was posted to more than 400 farms representing approximately 90% of the large-scale pig farms in Hungary in 2004. Twelve per cent of the questionnaires were returned, and this was increased to 22.3% by a second call. In this way 93 questionnaires were acquired. An additional 47 questionnaires were obtained by personal farm visits by the authors.

In the second phase of the study a scale of scores was attached to different, directly measured variables. Generally, the higher scores indicated a better performance or condition. After the data processing, the results of the survey were analysed by mathematical-statistical methods. The statistical evaluation of questionnaires was carried out using the integrated statistical program package SPSS 11.5 (SPSS Inc, 1999). Based on the survey, a matrix was produced which contained the values for each farm according to different score values. In order to make these different values estimated on different scales comparable, the data were transformed into a normal distribution having 0 expected value and 1 standard deviation. This is the so-called z-transformation (Norusis, 1986).

Regression analysis models the relationship between one or more dependent variables and the independent variables. If there is more than one independent variable, it will be a multivariate regression. Path analysis is an extension of the multivariate regression model, when a series of regression equations is tested simultaneously. A path model is a diagram relating to independent, intermediary and dependent variables; arrows indicate causation between the variables (Hoyle, 1995). Exogenous variables in a path model are those with no explicit causes. In our case these were for example management strategy and stall construction. Endogenous variables include intervening causal variables and dependents. Intervening endogenous variables have both incoming and outgoing causal arrows (e.g. veterinary practice and piglet management practice) in the path diagram. The dependent variables have only incoming arrows. The estimated significant regression coefficients have been indicated by the arrows mentioned above. The standard errors of estimations are given in parentheses. The path model was determined by Mplus® software (Muthén and Muthén, 2004). The fitness of the model was tested by chi-square and Root Mean Square Error of Approximation (RMSEA) statistics (Marcoulides and Schumaker, 1996).

Results

The basic technical and technological indices of swine farms are summarised in Table 1 and the basic characteristics of breeding and animal health technology in farms investigated are summarised in Table 2. The mortality of animals in different phases of technology are as follows: 8.9% for the suckling piglets, 4.3% for the weaned pigs and 2.5% for the finishing pigs. The epidemiological status of pig farms was estimated by scoring the different disease statuses. A 0 score value was given to farms infected with a given disease, 1 to those ones with no clinical manifestations, 2 to farms having defence with vaccination and 3 to those ones being free from disease.

Table 1: Basic indices of the pig farms participating in the study, with standard deviations given in parentheses where applicable.

Indices	Value and range
Average age of buildings	26.5 (±8.2) year
Average time from the latest reconstruction	5.3 (±4.8) year
Average number of sows in 2003	587 (±487)
Proportion of fattening farms	42%
Proportion of breeding farms	6%
Proportion of mixed farms (for both breeding and fattening)	52%
Legal framework of the pig-breeding activity	
Family farm	12%
Private entrepreneurship	10%
Limited partnership	8%
Limited liability company	28%
Incorporated company	27%
Co-operative	15%

The basic technical and housing features of the pig farms are summarised in Table 3. The farms were scored according to the different technical and housing indices. As a scoring system the variables are measured on a metric scale as follows: below average with more than 20% is equal to 0, average ± 20% to 1, above average with more than 20% to 2. In dichotomy questions: ‘yes’ equals 1, 0 means ‘no’.

Table 2. The characteristics of technology and veterinary practice management for (a) breeding sows and suckling piglets; (b) pig rearing and (c) pig fattening.

Characteristics	Positive answers (%)		
	a	b	c
Application of "all in all out" principle	82	65	40
At least one week service period of rooms	29	53	40
Preventive anticoccidial treatment of piglets before weaning	30		
Vaccination of piglets before weaning against *Mycoplasma hyopneumoniae*	19		
Grouping of weaned piglets according to age and sex		33	
Separate grouping of weak weaned piglets		21	
At least one of compound feeds contains acidifying agent		42	
Preventive vaccination before housing against *Mycoplasma hyopneumoniae*		11	
Preventive vaccination before housing against *Actinobacillus pleuropneumoniae*		8	
Preventive vaccination before housing against *Pasteurella multocida*		4	
Separate rooms for groups of animals having more than two weeks difference in age			37
Separate grouping of weak fattening pigs			35
Regular antiparasitic treatment			43
At least one of compound feeds contains acidifying agent			20
Vaccination of fattening pigs against *Mycoplasma hyopneumoniae*			15
Vaccination of fattening pigs against *Actinobacillus pleuropneumoniae*			5

Table 3: The basic technical and housing parameters of the investigated farms. Average values with standard deviations given in parentheses where applicable.

Variable	Value
Space allotment for pregnant pigs in the sow house (m^2)	3.5 (1.6)
Space allotment for starter pigs (m^2)	0.3 (0.2)
Air-space for starter pigs (m^3)	1.1 (0.4)
Space allotment for grower pigs (m^2)	1.5 (0.8)
Air-space for grower pigs (m^3)	9.2 (1.0)
Space allotment for finishing pigs (m^2)	1.8 (0.5)
Air-space for finishing pigs (m^3)	3.0 (1.1)
Ventilation % (Yes/All)	18
Paddock (outrun) % (Yes/All)	32
Separate penning of virgin gilts % (Yes/All)	28

The commitment of managers to a quality oriented development strategy was measured by self-reported acceptance of different statements, reflecting different strategic development possibilities of the farms. Respondents were asked to express the level of acceptance of different statements on a 1-5 scale (5: very important; 1: absolutely unimportant). The results of this survey are summarised in Table 4.

The most important indices of veterinary practice management in the farms were then evaluated according to the following aspects: the number of work hours spent on observation in the herd, frequency of using different advisory services, authority level of veterinary specialist in field problems, his/her indirect and/or direct influence on animal health conditions, frequency of serological profile analysis by outside institutions and the cost of medications/100 swine. Table 5 shows the basic indices of veterinary practice management.

Table 4. Importance of different ways of development according to farm managers. 5: very important; 1: absolutely unimportant. Standard deviations are shown in parentheses.

Way of development	Average score
Increasing the professional knowledge of the blue-collar workers of the farm	3.5 (1.2)
Improvement of the quality of feeds	4.4 (1.1)
Increasing the professional knowledge of the white-collar workers of the farm	2.6 (1.5)
Higher utilisation of the benchmarking for the evaluation of the farm	3.5 (0.9)
Improvement of the efficiency of veterinary attendance	4.2 (1.0)
Increasing the use of preventive programmes	4.0 (1.1)
Improvement of the technology	3.7 (1.2)
Improvement of the feed conversion ratio	4.5 (1.3)
Improvement of category distribution of pig meat produced by the farm	3.7 (1.2)
Improvement of the information and traceability system of the farm	3.8 (1.0)

Table 5: Indices of veterinary practice management.

Indices	Score	Distribution of responses (%)
1. Number of work hours spent on observation in the herd (work hours per/100 sows)		
More than 4 work hours per 100 sows	4	31
4 work hours per 100 sows	3	40
3 work hours per 100 sows	2	23
Less than 3 work hours per 100 sows	1	6
2. Frequency of using different advisory services		
Regular utilisation of independent scientific advisory services	4	12
Regular utilisation of advisory service of pharmaceutical – or feed producers	3	34
Occasional utilisation of advisory service of pharmaceutical – or feed producers	2	38
Not at all	1	16
3. Authority level of veterinary specialist in field problems, influencing indirectly and directly the animal health conditions (or status)		
Decision rights in problems, influencing directly or indirectly the animal health conditions of the stock (e.g. feeding)	3	11
Decision rights in problems, influencing directly the animal health conditions of the stock (e.g. planning of vaccination programs, medication programmes)	2	65
Decision rights in problems relating to the observance of rules and to the prevention of infectious diseases	1	24
4. Frequency of serological profile analysis by outsider institution		
Regularly	3	16
Occasionally	2	75
Practically never	1	19
5. Frequency of diagnostic analyses beyond the compulsory surveys		
Monthly	5	5
Quarterly	4	13
Half-yearly	3	45
Yearly	2	37
Less than once per year	1	7
6. Cost of medications /100 swine		
Below 2 €	5	28
2-4 €	4	48
4-6 €	3	17
6-7 €	2	4
above 6 €	1	3
Allowance of pig breeding for workers		
Yes	0	77
No	1	23

Finally, the most important indices of efficiency and profitability in the farms were evaluated (Table 6).

Table 6: Indices of efficiency of farms being investigated. Standard deviations are shown in parentheses.

Indices	Average
Pregnancy rate (%)	73.5 (14.0)
Weaned pigs/litter	8.2 (2.3)
Farrowing frequency (litter/sow/year)	2.2 (0.4)
Length of finishing period (days)	60.5 (11.1)
Rate of E and U meat class categories (%)	62.4 (19.5)
Feed conversation ratio in finishing period (kg/kg)	3.37 (0.68)
Annual live weight production per sow (kg/finishing pig)	37,452 (17,412)
Profitability (operational income/total cost of production) (%)	3.6 (2.4)

Based on the data above, structural equation modelling was elaborated to determine the influence of different factors on the efficiency of a swine farm. Contrary to our expectations, in order to get the fitness of the acceptable model nearly fifty attempts were needed, because it was not possible to find any statistically significant relationships between each different factor theoretically influencing the performance of pig breeding units. The chi-square test showed that the null hypothesis, according to which the model fits the data, cannot be rejected. This finding was corroborated by the RMSEA statistics. According to Hu and Bentler (1999) the recommended cut-off value is 0.06. The RMSEA estimation was 0.04, that is, the model fits well. The results of the analysis are summarised in Figure 1.

Discussion

Analysing the features of technology for breeding sows and suckling piglets as well as of veterinary practice management, the relative backwardness of current practice compared to 'optimal' or 'quasi-optimal' practice can be detected. It is very important to decrease pathogens in the environment, so in this sense the application of 'all in all out' principle is essential which is applied in more than three quarters of farms (Table 1).

The data in Table 2 show that 65% of farms use the 'all in all out' principle in the growing phase of production. Slightly fewer, around half of them, applied at least one week long service period of rooms. It is a positive sign that many farms use feed additives. The feed acidifiers are used alone on just a few farms but in spite of that, because of the stringent control of antibiotic treatments and the prohibition of Zn supplementation, this prophylactic method might come to the fore. Vaccination has a far smaller role in the finishing units. Regarding the veterinary practice management in the case of weanlings it is a positive sign that nearly two thirds of respondents apply the simultaneous housing/simultaneous vacating system. An at least one week long period between vacating and housing is a common practice in the case of more than half of respondents. The observance of this guideline is rather simple, as a consequence of the low utilisation of pig breeding capacities.

In the finishing phase of pig production only few farms can put into practice the 'all in all out' principle and a one week long service period of rooms. In most farms animals with more than two weeks difference in age can be found in the same room. The reason for that is the fluctuation in demand, the inadequate technology and the volatile herd rotation. In more than 40% of the herds regular antiparasitic treatment is applied. The use of acidifiers and vaccines is quite rare during fattening. Intensive use of mineral additives can be explained by intensive advisory activity of feed producers, because they try to increase their market share in the shrinking Hungarian market. The relatively low rate of application of separation can be explained by relative obsolescent building construction.

Analysing the causes of mortality, it can be stated that crushing piglets and *E. coli* diarrhoea are the most common problems. In the pig rearing phase the mortality rates in most farms are high, almost 4.5%. The causes could be the inadequate housing and feeding as well as sometimes no proper treatment. In the fattening phase the average mortality rate is 2 to 4%, in the survey the mean was 2.5%. The different respiratory diseases, swine dysentery, Post-weaning Multisystemic Wasting Syndrome (PMWS) and Porcine Dermatitis and Nephropathy Syndrome (PDNS) are the outstanding agents. The comparative analysis of the Hungarian epidemi-

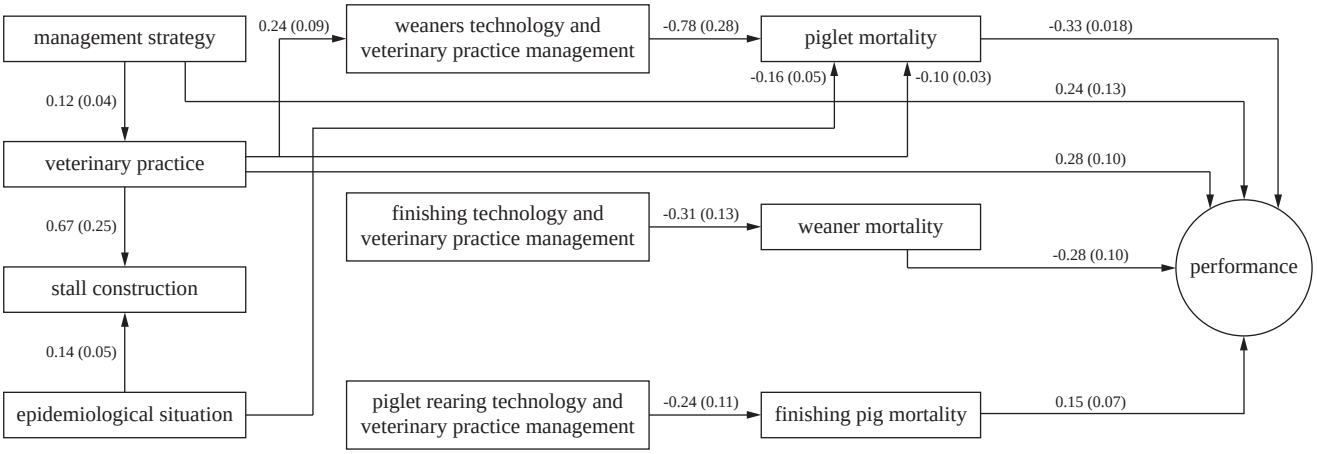

Figure 1: A model of factors influencing the performance of pig breeding units. The significant regression coefficients of structural equations are shown above the arrows and their standard errors in parentheses.

ological and herd health situation with that of the 'so-called' developed states could be a topic of further investigation.

The results of the basic technical and technological indices of swine farms are partly similar or equal to the findings of the survey done at the request of the Hungarian Ministry of Agriculture and Rural Development in 2001 (Ráki, 2003). The basic architectural-technical features in the majority of the cases in our study satisfy the minimal requirements, often as a consequence of the decreasing number of pigs as well as the lower average weight of pigs.

The majority of respondents are committed to improve the quality and efficiency of production. In line with our expectations the improvement of feed conversion ratio and that of quality of feeds has primary importance. Accepting the importance of improvement of veterinary health care can be assessed as a sign of quality-oriented development. At the same time, the human resource development and the acceptance of a benchmarking approach is relatively low. Improving the quality distribution of pork meat produced by the farm, under the current economic circumstances, in itself is not a decisive factor for farm profitability. Setting up an informational background for improvement of efficiency, profitability and quality of production as well as building up traceability systems is not yet an integral part of the development strategies of Hungarian swine farms.

The results of structural equation modelling highlight the effects of different factors on the performance of a swine farm. Analysing the relationships between different indicators, it is clear that there is a significant relationship between the strategy of the management and the veterinary practice. The significant coefficient of variable called 'management strategy' on veterinary practice and performance of the farm objectively proves our preliminary, intuitive expectation about the importance of commitment of management to upgrade the animal health status of the farm. This fact highlights the importance of efforts for enhancement of veterinary and stock farming technology knowledge of farmowners and managers. That is why the postgraduate training courses and further education for pig farm owners could be important tools for improving the competitiveness of pig breeding.

The relationships between veterinary practice, stall construction and epidemiological situation were also significant. These relationships are well documented in the literature. Previously, Maes *et al*. (2002) and Mouricout (2004) have shown the influence of stall construction on epidemiological status. Thrusfield (2005), in his monumental work, demonstrated the decisive influence of veterinary strategy on epidemiological status of pig breeding units. The impact of technical, housing conditions of breeding on the epidemiological status of herds highlights the importance of modernisation of production facilities as well as the need for application of veterinary considerations in the planning, building and reconstruction phases.

In line with our previous expectations, there was a direct relationship between technology and respective mortality. This is a further proof of the need for better co-operation between the veterinarians and technological specialists. On the other hand, the impact of mortality on performance of swine farms emphasises the economic importance of the veterinary activity.

The results of our research are preliminary, because by increasing the number of farms participating in the survey, conducting a more detailed analysis of veterinary status, and examining the activities of swine farms under more stable economic conditions could reveal even more characteristic relationships, giving the possibility for a sophisticated, benchmark-type analysis of the pig units. However, it is clear that the structural equation modelling can be used efficiently in determining the interrelationships of factors which influence the performance of pig breeding farms. These results could contribute to (1) the development of decision support systems, (2) advisory services, and (3) curricula in graduate as well as postgraduate education.

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