The impact of herd health on the efficiency of dairy farms

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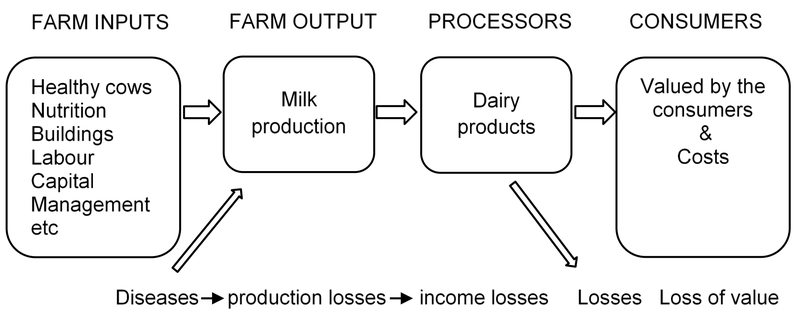
Abstract

Maximization of profit is one of the main interests of any farmer. Profit depends on managerial decisions and many economic factors, but also on the health of the herd. Thus, it is important to study how different factors related to herd health impact farms' economic performance. The objective of this paper is to determine how herd health influences farm technical efficiency by comparing Estonian farm data from two periods, the years 2012 and 2017. Typically, the major herd health issues are related to udder problems, followed by reproduction issues and limb disorders. We used the FADN (Farm Accounting Data Network) database and data from Estonian Livestock Performance Recording Ltd. The two-stage mathematical approach was chosen as the research method. In the first stage the DEA (Data Envelopment Analysis) was used to estimate farms' technical efficiency. The output-oriented VRS (Variable Returns to Scale) approach was applied to the data of 64 farms. In the second stage, we used the FRM (Fractional Regression Model) to define which the technical efficiency drivers were among herd health and economic factors. The study revealed that major changes have occurred between the two periods analysed. The main herd health factors influencing farms' technical efficiency are the somatic cell count (SCC) and age at first calving.

Impact of diseases on milk production



Data

The output and input variables for DEA are from FADN. The total sales revenue includes sales revenue from milk and other sales revenue from agricultural products. The number of cows represents the annual average number of cows in the farm. The land variable is measured in hectares and includes all arable land. The labour variable is measured in hours and includes all working hours, both paid and unpaid. The capital expenditure is equalized to the annual depreciation. Intermediate consumption has been included in this work as production costs.

The variables for FRM are from FADN and Estonian Livestock Performance Recording Ltd.

Comparing the DEA and FRM variables in 2012 and 2017, some important changes can be observed between 2012 and 2017 (Table 1).

Results of DEA

The average technical efficiency has grown between the years 2012 and 2017. The technical efficiency was 0.803 (80.3%) in 2012 and 0.835 (83.5%) in 2017. The number of technical efficient farms was 13 (20.3%) in 2012 and 16 (25%) in 2017.

The farms are divided into three groups according to their technical efficiency change from 2012 to 2017 (Table 2). Farms whose technical efficiency change was above 0.05 points are in the group with positive change in technical efficiency (PosCh). Farms whose technical efficiency change was in the range of 0.05…0.05 points are in the group with neutral change in technical efficiency (NeutCh). If the farm's technical efficiency decreased by more than 0.05 points, the farm is in the group with a negative change in technical efficiency (NegCh).

The group with positive technical efficiency change had the biggest growth in sales revenue (+72.9%) and in the number of dairy cows (+29%). Also, their milk yield increased and SCC decreased by +14.8% and -31.2% respectively.

Table 1. Descriptive statistics of the variables for DEA and FRM

		2012					2017				
Variables	Unit	Min	Max	Mean	St. Dev	Median	Min	Max	Mean	St. Dev.	Median
Output and inputs in DEA											
total sales revenue	thousand euros	25.9	9,970.3	935.7	1,500.0	380.9	32.8	12,607.1	1,322.6	2,060.4	422.8
dairy cows	number	19	1,638	302	366	154	16	1,840	348	438	140
agricultural area	ha	37	5,729	922	1,156	447	39	5,612	912	1,143	366
labour	h	2,150	254,376	38,424	48,902	14,078	2,100	368,925	38,789	57,096	13,150
capital expenditure	thousand euros	3.0	735.4	133.7	159.1	63.3	3.1	792.7	168.1	200.6	64.5
intermediate consumption	thousand euros	29.3	9,510.8	969.8	1,477.0	376.9	40.2	11,317.4	1,185.3	1,783.4	437.4
Variables in FRM											
technical efficiency	score	0.394	1.000	0.803	0.154	0.806	0.514	1.000	0.835	0.135	0.837
milk yield per year	kg cow^{-1}	4,987	9,953	7,667	1,346	7,653	5,426	12,814	8,682	1,728	8,801
milk fat content	%	3.32	4.77	4.11	0.25	4.10	3.42	4.73	4.06	0.26	4.02
milk protein content	%	3.08	3.62	3.36	0.09	3.36	3.19	3.58	3.35	0.08	3.35
somatic cell count	10^3 ml^{-1}	129	609	343	121	325	67	1,070	266	139	267
age at first calving	days	735	1,305	875	124	843	704	1,249	835	107	814
productive period	days	844	2,247	1,317	340	1,210	881	2,817	1,212	315	1,130
age at culling	days	1,613	3,233	2,193	381	2,131	1,644	3,807	2,076	368	1,980
culling rate (udder)	%	0.0	57.1	27.8	15.1	28.6	0.0	50.0	24.0	11.2	22.8
share of EHF	%	0.6	100.0	76.5	32.6	93.4	0.0	100.0	78.4	33.9	99.8
share of own feed	%	18.4	100.0	59.7	19.7	57.8	4.7	95.0	56.3	17.3	54.8
feed costs per milk kg	euro kg^{-1}	0.075	0.292	0.174	0.049	0.171	0.085	0.310	0.171	0.042	0.164

Table 2. Changes in variables in three technical efficiency change groups between 2012 and 2017

Variables	Unit	Variables increase/decrease (%)		
		PosCh	NeutCh	NegCh
total sales revenue	thousand euros	+621 (+72.9)	+341 (+31.8)	+168 (+20.2)
dairy cows	number	+94 (+29.0)	+32 (+10.9)	+12 (+4.0)
agricultural area	ha	-61 (-5.9)	-27 (-2.8)	+80 (+10.9)
labour	h	-78 (-0.2)	+3,931 (+11.4)	-4,541 (-10.7)
capital expenditure	thousand euros	+36 (+23.7)	+43 (+37.1)	+20 (+14.3)
intermediate consumption	thousand euros	+276 (+28.6)	+205 (+19.2)	+156 (+19.0)
milk yield per year	kg cow^{-1}	+1,110 (+14.8)	+1,159 (+15.4)	+679 (+8.3)
milk fat content	%	-0.017 (-0.41)	-0.072 (-1.75)	-0.045 (-1.09)
milk protein content	%	+0.018 (+0.53)	-0.024 (-0.71)	-0.009 (-0.26)
somatic cell count	10^3 ml^{-1}	-112.0 (-31.2)	-75.5 (-24.9)	-35.1 (-9.2)
age at first calving	days	-54.7 (-6.3)	-33.3 (-3.8)	-29.3 (-3.4)
productive period	days	-181.3 (-12.5)	-79.0 (-6.2)	-48.4 (-4.0)
age at culling	days	-211.1 (-9.0)	-60.4 (-2.8)	-86.6 (-4.1)
culling rate (udder)	%	+5.4 (+27.1)	-12.0 (-36.2)	-2.6 (-8.7)
share of EHF	%	+2.0 (+2.6)	-0.7 (-0.9)	+5.8 (+8.0)
share of own feed	%	-6.6 (-10.9)	-3.9 (-6.7)	+1.3 (+2.1)
feed costs per milk kg	euro kg^{-1}	-0.022 (-11.8)	+0.011 (+6.9)	+0.002 (+0.9)
number of farms	number	21	26	17

Results of FRM

Mastitis is one of the most frequent diseases and causes of loss of income and milk, and increased costs (Horvath et al., 2017; Hogeveen et al., 2019). Technical efficiency studies have found that higher SCC predicts inefficiency or has a negative impact on technical efficiency (Allendorf & Wettemann, 2015; Luik-Lindsaar et al., 2018; Luik-Lindsaar et al., 2019). Cinar et al. (2015) found that high SCC has a negative effect not only on milk yield but also on milk composition and quality.

The SCC had a statistically significant negative impact on technical efficiency in 2012. The average partial effect shows that if the SCC increased by 100 x 10^3 ml^{-1}, the technical efficiency would decrease by 0.02 point. SCC is an indicator of potential mastitis, and is associated with reduced animal health (Telldahl et al., 2019). Thus, all kind of preventions of mastitis (Barkema et al., 2015; Gargiulo et al., 2017) together with better housing conditions (Ruud et al., 2010; Villettaz Robichaud et al., 2019) are important factors to increase income and reduce costs, which in turn leads to increased technical efficiency. The SCC had no significant impact on technical efficiency in 2017.

Feed costs per kg milk had a significant negative impact on technical efficiency in 2012. According to the average partial effect, if the feed costs increased by 0.01 euro per kg milk, the technical efficiency would decrease by 0.0123 points. The value of feed costs per kg milk contains information on both the cost and milk production: the higher the milk production, the lower the cost per unit of milk. A healthier herd has a better dry matter and nutrient intake therefore every euro spent on feed produces more milk and revenue in healthier herds. Feed cost per kg milk decreased slightly (-1.72%), but average milk yield increased markedly (+13.2%) in 2017 compared to the year 2012. Considering the increase in milk yield, it would have been reasonable to expect a greater decline in feed costs per kg milk. One of the reasons why the latter was not the case was the increased share of purchased feed, which is mainly concentrated feed at a higher price.

The share of home-grown feed had a significant negative impact on technical efficiency in 2012 and 2017, which means that a higher share of purchased feed (concentrated feed) helps to achieve higher technical efficiency through higher milk yield. Therefore, it is important to achieve lower production costs through focusing more on having a healthier herd with better food intake and higher milk yield.

One of the factors that determines a dairy herd profitability is the productive period, which depends on the age at first calving. The age at first calving had a significant negative impact on technical efficiency in 2017. The age at first calving decreased by 40 days from 2012 to 2017.

The average age at first calving was 27.4 months in 2017 in our sample. According to Froidmont et al. (2013), the optimal age at first calving is in the range of 22–26 months. Reducing the age at first calving can lead to an increase in technical efficiency. The decrease in age at first calving by 1 month increases technical efficiency by 0.0122 points.

The share of EHF had a significant positive effect on technical efficiency in 2012 and 2017. The average partial effect showed that if the share of EHF increased by 1%, the technical efficiency would increase by 0.0008 points.

The decreased SCC and age at first calving are positive changes in Estonian dairy herds according to our sample farms, whereas the productive period and longevity are factors that need to improve. The share of culling caused by udder problems has no significant impact on technical efficiency.

The dairy cattle information system Vissuke is a good tool for recording and analysing herd health at farm level for Estonian dairy farmers (Lillik, 2015). The NGO Piimaklaster, in cooperation with the Estonian University of Life Sciences, has carried out an HHMP project (2017–2019) whose results show that systematic work on livestock health improves animal health and productivity, as well as economic profitability of production through this (Mõtus et al., 2019). Dairy farmers have to pay attention to cow health in order to remain competitive and ensure profitability.

Conclusions

Herd health is an important issue for any farmer as it influences the farm's revenue, costs and technical efficiency. Increased consumer awareness of healthy food and animal welfare requires farmers to produce high quality raw milk. Therefore, today it is not only crucial to focus on quantities but to also have an increased focus on the high quality of raw milk.

One indicator of udder health is the number of somatic cells in raw milk. High level of SCC characterizes herd health and is associated with losses in both the quantity and quality of milk. The present study showed that a high SCC has a negative impact on farm technical efficiency. High SCC increases costs and decreases revenue, therefore it directly influences farms' economic performance. It emerged that decreasing the age at first calving increases technical efficiency. Therefore, reducing the SCC and age at first calving are the key factors to increasing technical efficiency.

To ensure healthier herds, farms' technical efficiency, sustainability of production and catering to consumers' expectations, it is essential to manage farms consciously and include herd health programmes into the farm management process.

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