Economic value of productive life of cows on organic dairy farms in the United States

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Abstract

Organic milk production is an important sector of the US dairy industry. Productive life, defined as the time that a cow remains in the herd after first calving, is a trait of economic importance in organic dairy farming affecting the age structure of the herd and replacement costs. Productive life is of economic importance for inclusion in breeding objectives for organic milk production, which determine its value for selection. The objective of this study was to estimate the economic value (EV) of productive life for cows on certified organic dairy farms in the US using a farm-simulation model. Annual net farm income (NFI) per cow was calculated as gross income minus production costs. Income was derived from the sale of milk, disposed animals and other income. Milk income was calculated as US$ 0.809/kg milk. Cost of organic feed was US$ 0.308/kg DM. The average productive life of the herd was 1,302 d with an annual replacement rate of 22.1%. The herd NFI was US$ 520.70/cow and the EV for productive life was US$ 1.24/d. This value is higher than the EV of productive life included in the Net Merit (US$ 0.69/d) or Grazing Merit (US$ 0.43/d) indexes used for conventional US dairy cattle.

Keywords: replacement rate; farm profit; selection index

Introduction

Organic milk production is an important sector of the US dairy industry. In 2010, organic food sales reached $28.6 billion, representing 4.0% of the total United States food market. Organic dairy products were the second-largest category of organic foods and sales in 2010 were $3.9 billion, representing almost 6% of all marketed dairy products in the United States (Organic Trade Association, 2011). The growth of the United States organic dairy industry is driven by the willingness of some consumers in the United States to pay more for dairy products produced without the use of antibiotics and with documented pasture access for dairy cattle (Olynk et al. 2010; Mullen et al. 2013). The cows must be managed organically and fed a diet composed of only certified organic feed. Also, cows must have year-round access to the outdoors, at least a 120-d grazing season on organic pastures, and obtain at least 30% of their dry matter intake from pastures during the grazing season (USDA National Organic Program, 2013).

Conventional dairy farmers in the United States select bulls and cows based on the Net Merit index (NM$) (Van Raden 2017), whereas pasture-based dairy producers select the best animals based on a Grazing Merit index (GM$) (Gay et al. 2014); both indexes are calculated by the Department of Agriculture of the United States. These indexes estimate lifetime profit of a cow based on income and expenses relevant to conventional or pasture-based dairy producers. Organic heifer replacement and milk production costs exceed conventional costs mostly because of higher feed prices and more intensive use of labour and land per hundredweight (cwt) of milk produced. In 2005, organic operating costs were an estimated $5.48 per cwt higher than that of conventional dairies, but the price premium for organic milk was $6.69 per cwt, meaning that organic producers earned about $1.21 more per cwt over operating costs, on average, than conventional producers (McBride & Greene 2007).

Productive life, defined as the time that a cow remains in the herd after first calving, receives an economic value of US$ 0.69/day and US$ 0.43/day in the NM$ and GM$ indexes, respectively. Productive life is also a trait of economic importance in organic dairy farming affecting the age structure of the herd and replacement costs, which determine its value for selection. The average lactation number of animals on organic farms was 2.6 lactations, which was greater than average lactation number of animals in conventional farms (2.3 lactations), and a greater percentage of first-lactation heifers were found on conventional farms than on organic farms (Stiglbauer et al. 2013).

The objective of this study was to estimate the economic value for productive life of cows on certified organic dairy farms in the US using a farm-simulation model.

Materials and methods

A deterministic model developed by Lopez-Villalobos et al. (2000) was used to simulate, on an annual basis, the nutritional, biological and economic performance of an organic dairy herd located in Indiana with a representative age structure (Table 1). Cattle in the herd, including replacements, had year-round access to organic pasture for grazing for at least 120 days during year, and obtained 20% of the dry matter requirements. Cows first calved at 24 months and maintained an average calving interval of 12 months. Surplus female progeny and all bull calves were sold for beef within the 1st week after birth. Numbers of animals were updated each year using a herd-growth model (Azzam et al. 1990), keeping constant the age structure of the herd according the survival rates for each age class.

Causes of disposal of young replacements and cows were sorted into voluntary culling (suitability for dairying including low production, type and temperament) and involuntary culling (deaths, mastitis, metabolic problems, poor fertility and age). Surviving cows were culled when they reached 11 years of age. The average culling rate of cows was 22.1% per annum, comprised of 3.3% mortality, 11.0% mastitis, 1.0% lameness, 4.7% poor fertility, 1.7% low production and 0.4% age. These values were obtained from averages of the case study organic herd.

Requirements for net energy of the entire herd, including requirements for the maintenance and growth of the replacements, were calculated using the formulae proposed by AFRC (1993) and converted into Mega calories. The ration for cows was composed of 35% pasture, 28% baleage, 10% oat and 27% of mixed certified organic grains, on a dry matter basis, with a net energy content of 1.651 Mcal and cost of US$ 0.308/kg DM. The ration for heifers was composed of 20% pasture, 20% baleage, 10% oat and 50% of mix of certified organic grains, on a dry matter basis, with a net energy content of 1.772 Mcal and a cost of US$ 0.363/kg DM. The cost per DM of the ration included the cost of pasture, which was estimated at US$ 0.221/kg DM.

Herd totals per year for production of milk, fat, protein and other solids (lactose plus minerals) were calculated as the sum product of the number of effective lactating animals in each age class multiplied by the corresponding average milk production for the class. The number of effective animals for each class was calculated as the number of animals that survived at the end of the year plus 80% of culled animals. The herd average for milk production and body weight was obtained as the herd total divided by the number of lactating cows that started the year.

Annual net farm income (NFI) per cow was calculated as gross income minus production costs. Income was derived from the sale of milk, disposed animals and other income. Milk income was calculated as US$ 0.809/kg milk regardless of milk composition. Beef income was derived from the sale of male calves (as beef or breeding stock), surplus female calves, and culled heifers and older cows. Sale values were US$ 3.64/kg, US$ 1.43/kg and US$ 1.32/kg body weight of calves, heifers and cows. No differential price was paid for cows according to the culling reason. Expenses included feed, operating, and depreciation costs per cow. Average farm production costs (US$ per cow) included labour 1,039, machinery hire 153, vehicle expenses 300, fuels 26, breeding 28, animal health 93, bedding 113, milking supplies 84, maintenance of building 14, taxes 69, real estate rent 163, insurance 51, electricity 86, interest 79 and depreciation 465. Additional costs (labour, animal health and breeding) for raising 1 yr and 2 yr olds were $222 and $206 per animal, respectively.

The economic value of productive life was calculated as the change in NFI per cow per day of productive life of the herd. To achieve longer average herd productive life the culling of cows for mastitis was reduced from 11 to 10%.

Results and discussion

Table 1 has the age structure of the simulated organic herd with a replacement rate of 22.1%. The herd was comprised of 119 milking cows with 31 rising 1-yr olds and 30 rising 2-yr olds. When culling rate for mastitis was reduced from 11 to 10%, replacement rate was reduced to 21.4% and average productive life of the herd was increased from 1,301.7 to 1,326.3 days (Table 2). The age structure of the herd changed (data not shown) and the number of rising 1-yr olds and rising 2-yr were reduced from 31 to 30 and from 30 to 29, respectively. The change in replacement rate caused several changes in the productivity and profitability of the herd (Table 2). Keeping the number of lactating cows (119 animals) constant, the average productive life of the herd increased from 1,301.7 to 1,326.3 days, herd average milk production per cow increased from 6,673 kg to 6,680 kg with less feed cost dedicated to the growing of replacements causing a reduction in herd feed costs and

Table 1 Age structure of a case study organic herd in the United States, lactation yields of milk, fat and protein; average live weight; and energy and dry matter requirements.

Age	0	1	2	3	4	5	6	7	8	9	+10
Number of animals	31	30	26	23	18	14	11	9	7	5	4
Percentage of the milking cows			22.1	19.7	15.4	12.1	9.5	7.4	5.8	4.5	3.6
Survival, %	96	88	78	78	78	78	78	78	78	78	78
Number culled	1	4	6	5	4	3	2	2	1	1	1
Number survived	30	26	21	18	14	11	9	7	5	4	3
Effective number[1]	31	29	25	22	18	14	11	8	7	5	4
Body weight, kg	177	409	527	572	588	594	595	596	596	596	596
Milk production, kg			5,921	6,601	6,904	7,200	7,133	7,066	6,999	6,724	6,316
Fat production, kg			257	285	298	310	306	302	298	286	267
Protein production, kg			194	216	226	235	232	230	227	218	204
Energy requirements, MCal/animal	3,800	6,576	10,121	10,072	10,069	10,217	10,119	10,041	9,970	9,730	8,542
DM requirements, kg/animal	2,145	3,711	6,130	6,101	6,099	6,188	6,129	6,081	6,038	5,893	5,174

[1] Effective number of animals was calculated as the number of animals that survived at the end of the year plus 80% of culled animals.

Table 2 Effect of replacement rate on average productive life of the herd and farm profitability.

	Mastitis culling rate = 11		Mastitis culling rate = 10	
	Farm	Per cow	Farm	Per cow
Replacement rate, %	22.1		21.4	
Productive life, days		1,301.7		1,326.3
Milk production, kg	759,680	6,673	762,121	6,680
Fat production, kg	32,687	287	32,786	287
Protein production, kg	24,798	218	24,874	218
Milk income, US$	614,513	5,164	616,592	5,181
Beef income, US$	31,774	267	31,194	262
Total income, US$	685,438	5,760	686,937	5,773
Feed costs, US$	276,238	2,321	274,520	2,307
Other operating costs, US$	347,242	2,918	346,819	2,914
Total costs, US$	623,480	5,239	621,340	5,221
Net farm income, US$	61,959	520.7	65,597	551.2

increased milk income. The NFI per cow increased from US$ 520.70 to US$ 551.20 (Table 2).

These results show that improving the average productive life of a herd results in improved herd milk production due to a higher proportion of mature cows with higher yields in the herd (Walsh et al. 2007; Lopez-Villalobos & Holmes 2010), reduced replacement costs (Gartner & Herbert 1981; Mohd Nor et al. 2015), and a reduction in health costs due to fewer veterinary treatments (Beaudeau et al. 1995; Kerslake et al. 2018). The effect of reduced replacement rate on replacement costs in organic milk production systems is stronger than in conventional milk production systems because in the organic systems calves and heifers are fed expensive organic milk and grains.

This simulation model allowed the estimation of the economic value for productive life using representative milk prices and costs of an organic dairy farm located in Indiana. This value was estimated at US$ 1.24/day of productive life, which is higher than the EV of productive life included in the NM$ (US$ 0.69/d) or GM$ (US$ 0.43/D) selection indexes used for conventional and pasture-based US dairy cattle, respectively (Van Raden 2017). The difference between the estimated EV for productive life for the selection indexes and the EV estimated in this study reflects the differences in milk prices and production costs between conventional, pasture-based and organic milk-production systems of the United States.

The simulation model developed in this study can be used to estimate the EVs for other traits that can be included in a selection index for organic milk producers in the United States. Selection indexes for organic milk production have been proposed for Ontario, Canada producers (Rozzi et al. 2007) and other studies have identified the need to implement selection indexes for organic producers in Switzerland (Haas & Bapst 2004) and the Netherlands (Nauta et al. 2006). Productive life is of economic importance for inclusion in breeding objectives for organic milk production.

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