Proc. Assoc. Advmt. Anim. Breed. Genet. 20:319-322

PRODUCTIVE AND GENETIC DIFFERENCES BETWEEN COWS MANAGED ORGANICALLY OR CONVENTIONALLY

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SUMMARY

International demand for organic dairy products has been on the rise. The productivity of organic production systems relative to traditional systems is therefore of increasing interest. In August 2001 the Dairy Cattle Research Unit at Massey University allocated 44 cows managed as a conventional herd and 44 Holstein-Friesian cows managed as an organic herd to monitor the differences between organic and conventional dairy farming systems. Replacements for each herd were produced using semen from high breeding worth (BW) bulls but in the case of the organic herd the number of bulls available was restricted by the organic standards. To compensate for this restriction, a mate-selection program allowing crossbreeding was used to maximise the future production worth (PW) of progeny in the organic herd. Management of stocking rate and use of purchased supplements attempted to equalise total feed offered per cow in both herds. The objective of this study was to compare the productive and genetic differences between the two herds, for the production season 2008-09, the 7th season of organic management. Compared to the conventional herd, the organic herd had a higher proportion of Jersey genes (0.38 vs 0.20, P=0.001), similar milk production (4,019 vs 3,899 L, P=0.28), similar fat production (207 vs 208 kg, P=0.93), similar protein production (145 vs 143 kg, P=0.66), similar lactation length (268 vs 272 days, P=0.38), similar liveweight (465 vs 464 kg, P=0.97), lower BCS (4.09 vs 4.26 units, <0.05), slightly lower BW ($113 vs $125, P=0.13), similar PW ($128 vs $126, P=0.89). Results from this study show that, in organic herds, strategic selection of sires for crossbreeding to maximise PW of future replacements can compensate for the lower BW of the sires, caused by the limited number of high BW sires available for use on organic farms.

INTRODUCTION

Demand for organic dairy products has been on the rise in United States of America (McBride and Greene 2007) and Europe (Nauta *et al.* 2005). Organic milk production differs from conventional milk production systems in several ways. In Norway, organic dairy herds have an accentuated spring calving period, lower production intensity, a generally older herd, and a more complex breed composition than is found in conventional dairy herds. Also, Norwegian certified organic milk producers are allowed a maximum of 30% total energy intake per year from concentrates (Harden and Edge 2001). The objective of organic milk production is to employ local natural resources without use of chemical fertilizers and pesticides. A key focus of the organic farming system is the maintenance of health and well-being of cows in the herd, without the routine use of conventional treatments methods (e.g., antibiotics).

Milk production per cow in organic herds has been reported as lower than or similar to production per cow in conventional herds. A Norwegian study (Harden and Edge 2001) reported that milk production per cow in organic herds was lower than milk production per cow in conventional herds with only small differences in milk somatic cell counts. Similarly, a Dutch study (Nauta *et al*. 2005) showed that milk production was lower and somatic cell counts were higher in long-standing-organic dairy farms compared with conventional and recently converted organic farms.

A Danish study (Kristensen and Kristensen 1998) of 13 organic and 18 conventional herds over a three-year period found that the peak milk yield was lower in organic cows but lactation persisted at a higher level for longer in the organic herds, leading to only marginal differences in annual herd production levels.

In New Zealand, little information is available about milk production and composition of milk from cows that experience a farm's conversion from a conventional to an organic grazing system. In addition, the availability of semen meeting organic standards was from bulls that on average had lower Breeding Worth (BW) than the bulls from the premier sire dairy team that farmers normally used in conventional herds. Now (2013), certified organic dairy farms can use semen from the premier sire team. Breeding worth (BW) is an economic selection index that estimates a cow's or sire's ability to breed profitable replacements. Production worth (PW) is another economic selection index that estimates the efficiency with which a cow converts feed into farm profit.

The objective of this study was to compare the productive and genetic differences between an organic and a conventional herd for the production season 2008-2009. These research herds were part of the long term experiment set up at the Dairy Cattle Research Unit, Massey University, to establish and monitor the performance of grazing dairy cows managed on a conventional or an organic system of milk production.

MATERIALS AND METHODS

Description of data. Historical data for the 2008-2009 season, on calving and drying off dates, calving number (primiparous or multiparous), lactation lengths and herd-test records of individual cows from a whole-farm systems experiment comparing organic with conventional milk production at Massey University were analysed. Cows from the experimental herds contributed data on yields (kg/day) of milk (MY), fat (FY), and protein (PY); additionally, monthly records of liveweight (LWT) and body condition score (BCS) per cow were also available during the corresponding production season. Throughout the experiment, semen from bulls that had been progeny tested in New Zealand was used to produce replacement heifers. Cows in the conventional herd were inseminated with high BW premier sires and cows from the organic herd with semen of New Zealand dairy bulls that met the organic standards of BioGro New Zealand; organic bulls were fewer and had lower BW than premier sires. To compensate for the lower BW of the organic bulls, a mate selection strategy (Lopez-Villalobos *et al.* 2004) was implemented for the organic herd. The mate selection used a multiple objective optimization (Tozer and Stokes 2001) to maximise PW and fertility and minimise somatic cell score (SCS) of future replacements.

Statistical analyses. The MIXED procedure (SAS 2008) was used to fit Legendre polynomials of 4^{th} (for MY) or 3^{rd} (for FY and PY) order to the herd-test data using random regression analysis to estimate the lactation curve parameters of individual cows (Brotherstone *et al.* 2000). The resulting random coefficients of the Legendre polynomials and the cows' actual duration of lactation were used to calculate the yields per lactation of milk, fat, and protein. The yields per lactation of milk and milk components, as well as the cows' LWT, BCS, lactation length, the percentage of Jersey genes, BW and PW were subjected to analysis of variance to test for differences due to production system and calving number, using the GLM procedure (SAS 2008).

RESULTS

Based on the size of the Akaike information criterion of sequentially fitted Legendre polynomials (SAS, 2008), 3rd (for FY and PY) and 4th (for MY) degree Legendre polynomials provided the best fit for the description of the individual lactation curves of cows from the experimental herds. The random individual cow lactation curves, the fixed regression line for the overall lactation curve, and the respective scatter plots for each variable and herd are displayed in Figure 1. Least squares means from the analysis of variance comparing the experimental herds, after accounting for differences in cow calving number, are presented in Table 1. Cows in both herds had similar values for lactation length, liveweight, BW, PW and yields of milk, fat, and protein. Cows in the organic herd were thinner and had higher percentage of Jersey genes.

DISCUSSION

Milk production per cow in organic herds has been reported lower than in conventional herds (Hardeng and Edge 2001; Nauta *et al.* 2005). This is often attributed to lower intake of concentrates (Hardeng and Edge 2001) and lower total dry matter intake for cows on these systems (Sehested *et al.* 2003). In the present experiment, however, lactation curves and the corresponding lactation yields of milk, fat, and protein did not differ for the conventional and organic herds, even though the mean BW of the conventional herd was higher than the mean BW of the organic herd. However the most representative measure of phenotypic potential for farm profit is PW rather than BW, because PW accounts for permanent and heterosis effects during the productive life of the cow. Despite cows from the organic herd being of lower BW they were able to match their counterparts' production figures in the conventional herd by being thinner and, on average, of similar PW.

Multiple objective optimisation has been useful to select sires for multiple objectives. For example Tozer and Stokes (2001) illustrated the use of this technique to select sires that maximise Net Merit and minimize inbreeding in the future progeny. A similar technique was implemented in the selection of sires for the Massey University organic herd. The results from the present study show that, in organic herds, strategic selection of sires for crossbreeding to maximise PW of future replacements can compensate for the lower BW of the sires that satisfied standards for organic production.

Table 1. Least squares means by production system and calving number for the yields of milk, fat, and protein, the percentage of Jersey genes, Breeding Worth, Production Worth, liveweight, body condition score (BCS) and lactation length of grazing dairy cows managed on a conventional or an organic system of milk production during 2008-09, the 7th season of organic management

Trait	Production system		SED*	P
	Conventional	Organic		
Milk yield (kg/cow/lactation)	3,899.0	4,019.0	110.4	0.28
Fat yield (kg/cow/lactation)	208.0	207.0	5.9	0.93
Protein yield (kg/cow/lactation)	143.0	145.0	3.2	0.67
Jersey genes (%)	20.4	37.8	0.05	0.001
Breeding Worth ($)	124.5	112.5	7.9	0.13
Production Worth ($)	125.7	127.9	15.5	0.89
Liveweight (kg)	464.3	464.8	11.2	0.97
BCS (units, scale 1 to 10)	4.26	4.09	0.07	0.05
Lactation length (days)	272.0	268.2	4.5	0.38

**SED = standard error of the difference.*

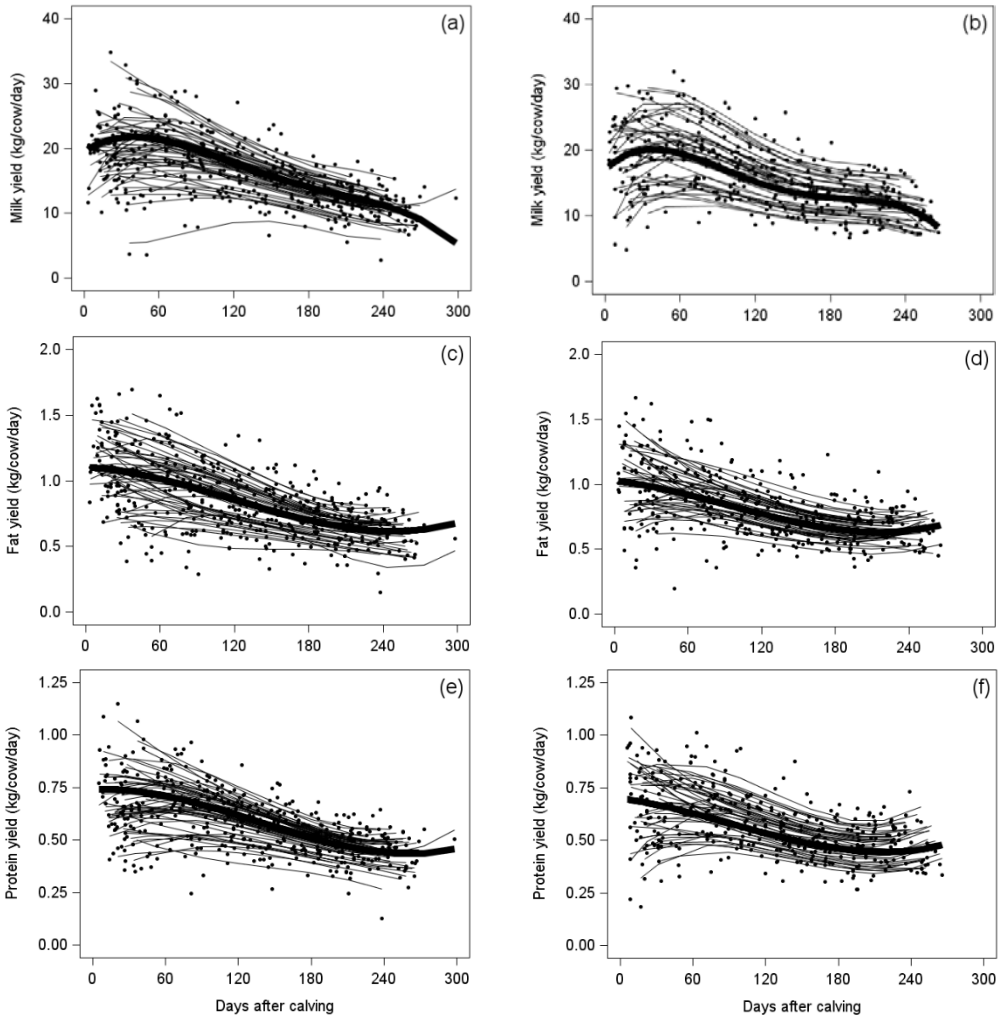

Figure 1. Scatter plots (solid black dots), overall fixed regression (thick black solid lines) and individual cow lactation curves (solid thin black lines) after fitting a 4th degree Legendre polynomial for MY (a: conventional; b: organic), and a 3rd degree Legendre polynomial for FY (c: conventional; d: organic) and PY (e: conventional; f: organic) of grazing dairy cows for the 2008-2009 production season.

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