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Short communication

Differences between dairy cows descending from artificial insemination bulls vs. dairy cows descending from natural service bulls on organic farms in Switzerland

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ABSTRACT

This study investigated differences between phenotypes of daughters of artificial insemination (AI)-bulls and daughters of natural service (NS)-bulls, respectively, on organic dairy farms in Switzerland. Organic rules recommend the use of natural mating. Therefore it is of interest whether those two groups of phenotypes show different characteristics on organic farms. Only farms using both AI and NS with sires of the same dairy breed as the inseminated cows were included in the study. First lactations of 594 cows from 29 farms were analysed for daily milk yield (DMY), somatic cell score (SCS), and calving interval (CI). Furthermore, veterinary treatments and fat/protein ratios >1.5 and <1.1 in milk samples during the first 100 days of lactation indicating risks for metabolic disorders were investigated. General linear models and-for binary variables-logistic regression models were calculated to explore differences in health parameters and DMY. Service method (AI or NS) and DMY (except when DMY was the target variable) were included in the models as fixed effects and farms as random effects. Distances between farms where the bulls had been bred and farms where their daughters lived were calculated with a common route planning tool. Additionally it was examined whether the bull's farm of origin was organic or not. Dairy cows descending from NS-bulls showed a lower SCS and tended to have shorter CI and a trend to lower DMY compared to cows descending from AI-bulls. No effects of service method on other health parameters were found. Around 70% of NS-bulls and 26% of AI-bulls had been bred in the same regions (<100 km distance) as their daughters. No NS-bull, but 35% of AI-bulls came from abroad (≥ 300 km within Switzerland or from another country). 1.8% of AI-bulls and 30.8% of NS-bulls had been bred on an organic farm. One explanation for the effects found in cows descending from NS-bulls might lie in their better adaptation to local conditions. However, effects of the service method and the bull's environment of origin cannot be distinguished and it cannot be excluded that the chosen NS bulls had incidentally higher genetic merits for CI and SCS than AI-bulls. Further research on differences between NS- and AI-bulls and also on genotype x environment-interactions between organic and conventional environments is necessary.

1. Short communication

About 90% of all dairy cows in Switzerland as well as all over Europe are inseminated artificially (Bieber, 2004; Morrell, 2011; Nauta et al., 2005). Natural service (NS) is mainly used on low input and some organic dairy farms as well as in herds with fertility problems. The organic farming standards in the European Union (EU, 2007) as well as in Switzerland (BLW, 2013) recommend the use of NS on organic farms, but nevertheless allow artificial insemination (AI). Despite the great advantages of AI, its use is sometimes questioned within the organic agriculture sector. Disadvantages are seen (1) in unnatural behaviour of animals during artificial insemination and during ejaculate collection, which can cause stress reactions, especially in female animals during insemination (Nakao et al., 1994; Nauta et al., 2005), (2) in the possibility of bypassing natural selection of the best sperms in the female reproduction tract, because major selection takes place during processing of the ejaculates (Morrell, 2011; Nauta et al., 2005), and (3) in the use of mainly conventional AI-bulls which may not be well adapted to local/organic feeding- and husbandry conditions (Nauta et al., 2006a; Spengler Neff et al., 2012). AI-bulls used on organic farms are mostly identical with the ones used on

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conventional farms (Bapst et al., 2005; Nauta et al., 2005). NS-bulls are usually bred and reared in the region of the farms where they are used (Nauta et al., 2005), thus having been allowed to adapt to local conditions. AI-bulls are usually reared and kept in other regions and under different management conditions than where they are used (Nauta, 2005; Oldham and Dewhurst, 2004). Semen from well adapted AI-dairy bulls is not easily available for those farming systems unless semen can be taken from regionally bred and raised bulls living on low input or organic farms (Nauta et al., 2005). Most AI-bulls and their ancestors received higher amounts of concentrates than cows on low input and on organic farms (Nauta et al., 2005; Oldham and Dewhurst, 2004; Rauw et al., 1998). In Switzerland all organic dairy farms practice feeding systems with high ratios of pasturing (BioSuisse, 2013; BLW (Bundesamt für Landwirtschaft), 2013), often including alpine pasture feeding in summer. Concentrate input is not exceeding 10% of yearly rations on organic dairy farms (BioSuisse, 2013). The question arises whether there are differences between dairy cows on organic farms descending from NS-bulls and dairy cows descending from commercial AI-bulls. This study investigated phenotypical differences between these two groups of cows on Swiss organic dairy farms with regard to several production and health parameters.

The data source of the present study was the 'pro-Q-network', an on-farm research database consisting of health and production data from 295 organic and low input dairy farms in Switzerland (Ivemeyer et al., 2007). From this database all organic farms using both AI and NS, either one for at least 10% of the services, were chosen for the present study. Reproduction methods and bulls used were determined from the animal movement database (TVD, 2012), which is run by the Swiss government and from the databases of the breeding organisations. Addresses of the farms where the bulls had been bred and had lived were as well available from these databases. Only sires of the same dairy breed as the inseminated cows were included in the study. Only primiparous cows with a following second calving were included in order to calculate calving intervals (CI). 29 farms using both AI and NS, with 594 cows in total were included in the study. The main breeds were Swiss Brown Cattle, Swiss Fleckvieh and Holstein Friesian. The average use of AI was 46% ($\pm$25%). Ten farms used 10–29% AI, nine farms used 30–49% AI, three farms used 50–69% AI, and seven farms used 70–90% AI. To find out whether local breeding bulls had been used on the respective farms the distance between the farm where the investigated cow lived and the farm where its father had been bred was calculated for each cow by entering both addresses in a common route planner tool. Categories of '$<$20 km', '20–99 km', '100–299', and '$\geq$300 km within Switzerland or abroad' were generated. The addresses where the bulls came from were as well compared with the list of organic dairy farms which was provided by BioSuisse, the organic farmers' organisation of Switzerland (BioSuisse, 2015; confidential communication) to find out whether the bull had been bred on an organic farm. Data from monthly milk recordings of all animals' first lactations were used. Mean somatic cell score (SCS) per cow was calculated from all monthly recorded somatic cell counts (SCC) of the first lactation (SCS=mean of ($\log 2$ (SCC/100,000)+3; Wiggans and Shook, 1987)). Indicators for metabolic disorders were calculated from milk fat and milk protein contents during the first 100 days in milk: thresholds for disorders were predefined as follows: fat-protein-ratio (FPR) $>$ 1.5 was used as an indicator of imbalanced energy supply (Buttchereit et al., 2010; Heuer et al., 2000). FPR $<$ 1.1 was used as an indicator of rumen acidosis (Bramley et al., 2008). Both indicators were used as binary variables, indicating that an imbalance during the first 100 days was there or was not there. Veterinary treatment (VT) data from obligatory farm records were as well analysed as an indicator for cows' health status. All VT of udder health disorders, metabolic disorders, fertility problems, and parasitic diseases using antimicrobials, hormones, corticosteroids, non-steroidal anti-inflammatory drugs (NSAIDs), and infusions for metabolic diseases were counted as VT. Creating another binary variable, it was assessed for each cow if she was at least one time treated within the investigated lactation or not. Farm records for VT were available from 23 farms with 242 animals in total. VT data of 6 farms were not available. Only phenotypic data were included into models, because breeding values were not available for 280 of 321 NS-bulls. Generalised linear mixed effects models were calculated using daily milk yield (DMY), SCS, and CI as dependent variables, service method (NS: yes or no) as a fixed effect, and farm as a random effect. In models with CI and SCS as dependent variables DMY was included as a covariate. Breed was not integrated into models, because it was highly related to DMY. All dependent variables were evaluated for normal distribution of the residuals using QQ-plots. Residuals of DMY and SCS were normally distributed. Logarithmic transformation of CI resulted in normal distribution of the residuals of the transformed variable (CILog 2). Logistic regression models were calculated for all binary dependent variables, which were: VT within the first lactation and identified risks of metabolic disorders within the first 100 days of the first lactation (FPR $>$ 1.5 and FPR $<$ 1.1). Independent variables were as well service method, DMY and farm. All statistical analyses were carried out using the software SPSS 20.0 (SPSS Inc., Chicago, IL).

Means of DMY, SCS, and CI as well as numbers of cows with risk of metabolic disorders and numbers of cows with at least one VT in their first lactation are shown in Table 1. Models showed that DMY tended to be related to the service method (Table 2). There was a tendency to lower DMY in daughters of NS-bulls. SCS was significantly related to the service method: daughters of NS-bulls had lower SCS than daughters of AI-bulls. Higher DMY tended to be related to lower SCS (Table 2). CILog 2 tended to be related to the service method: calving intervals of animals descending from NS-bulls were shorter than of animals descending from AI-bulls. There was no significant relation between DMY and CILog2 (Table 2). Risks of metabolic disorders (FPR $>$ 1.5 or FPR $<$ 1.1) were not influenced by the service method (Table 3), and there was no connection of DMY with FPR $>$ 1.5 nor with FPR $<$ 1.1 (Table 3). Occurrence of at least one veterinary treatment during first lactation was not determined by the service method nor by DMY (Table 4). Farm had a significant effect on DMY, SCS, and FPR $<$ 1.1 and tended to be connected with CILog 2.

28.4% of NS-bulls and 3.7% of AI-bulls were locally bred on the same farm as their daughters or on a neighbouring farm ($<$20 km distance). 38.6% of NS-bulls and 22.3% of AI-bulls were bred within a distance of 20–99 km to their daughters' farms (same region).

Table 1
Descriptive statistics of daily milk yield (DMY), somatic cell score (SCS), calving interval (CI), and cows with risk of metabolic disorders (fat/protein-ratio: FPR $>$ 1.5 and FPR $<$ 1.1) and with at least one veterinary treatment (VT) during first lactation in the two groups: descending from AI-bulls and descending from NS-bulls.

	Cows descending from AI-bulls		**Cows descending from NS-bulls**	
		n		***n***
DMY (kg; mean, sd)	17.33 $\pm$ 3.57	273	16.21 $\pm$ 2.91	321
SCS (mean, sd)	2.13 $\pm$ 1.08	273	1.93 $\pm$ 1.02	321
CI (days; mean, sd)	384.38 $\pm$ 64.34	273	371.65 $\pm$ 54.30	321
CILog 2 (mean, sd)	8.57 $\pm$ 0.29	273	8.52 $\pm$ 0.19	321
FPR $>$ 1.5 (number; %)	66; 24%	273	61; 19%	321
FPR $<$ 1.1 (number; %)	93; 34%	273	143; 45%	321
VT (number; %)	20; 24%	82	38; 24%	160