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Feeding, production, and efficiency of Holstein-Friesian, Jersey, and mixed-breed lactating dairy cows in commercial Danish herds

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ABSTRACT

The objective of this paper was to compare efficiency measures, milk production, and feed intake for lactating cows in commercial herds using different breeds and production and milking systems. To accomplish this, we used all feed evaluations made by the Danish extension service during the period November 2012 to April 2013 for 779 herds, of which 508 were Holstein-Friesian (HOL); 100 were Jersey (JER); and 171 herds were a mixture of these 2 breeds, other dairy breeds, and crossbreeds (OTH). The annually recorded, herd-average energy-corrected milk (ECM) yield was 8,716 kg (JER) and 9,606 kg (HOL); and average herd size was 197 cows (HOL) and 224 cows (JER). All cows were fed a total mixed or partial mixed ration supplemented with concentrate from feeding stations, housed in loose housing systems with a slatted floor, and milked in either a parlor milking unit or an automatic milking system. Energy efficiency was calculated as net energy efficiency defined as total energy demand as a percentage of energy intake and as residual feed intake defined as energy intake (net energy for lactation; NE_L) minus energy requirement. Production efficiency was expressed as kilograms of ECM per kilogram of dry matter intake (DMI), kilograms of ECM per 10 MJ of net energy intake (NE_L), kilograms of ECM per 100 kg of BW, and kilograms of DMI per 100 kg of BW. Environmental efficiency was expressed by the nitrogen efficiency calculated as N in milk and meat as a percentage of N in intake, and as enteric emission of methane expressed as kilograms of ECM per megajoule of CH_4. Mean milk yield for lactating cows was 30.4 kg of ECM in HOL and 3 kg less in JER, with OTH herds in between. Mean NE_L intake was 122 MJ in JER, increasing to 147 MJ in HOL, whereas ration energy density between breeds did not differ (6.4–6.5 MJ of NE_L per kg of DMI). The NE_L intake and DMI explained 56 and 47%, respectively, of variation in production (ECM) for HOL herds but only 44 and 27% for JER. Jersey had a higher efficiency than HOL and OTH, except in nitrogen efficiency, where no significant difference between breeds existed. Most of the efficiency measures were internally significantly correlated and in general highly positively correlated with milk production, whereas the correlation to DMI was less positive and for JER negative for net energy efficiency, kilograms of ECM per kilogram of DMI, and nitrogen efficiency. Only little of the variation in efficiency between herds could be explained by differences in nutrient or roughage content of DMI. This could be explained by the fact that data were collected from herds purchasing feed planning and evaluation from the extension service.
Key words: Jersey, Holstein, efficiency, commercial herd, environmental impact

INTRODUCTION

Dairy farming has a long tradition of recording milk yields as a major source of information for evaluating individual cows and the productivity of herds. Information about feed intake at herd, or even individual-cow, level will significantly increase the scope for evaluation and planning of the production, leading potentially to an increased economic profit and reduced environmental load from the production (Maltz et al., 2013). To do this in an optimal way, tools are needed that can estimate the outcome as part of the planning process and for methods than can evaluate the production results, including benchmarking figures.

Feed is the largest of the running costs in intensive, confined milk-production units, and more than two-thirds of that feed is used for the group of lactating cows. Although feed is a large expenditure, it is possible for the farmer to influence the cost by using different types and amounts of feed and by changing the energy content and nutrient concentration in the ration. Feeding level, ration, and nutrient composition and energy concentration are known to affect production efficiency as well as the excretion of nutrients and emission of

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greenhouse gasses from the herd (Aguerre et al., 2011) and farm (Rotz et al., 2010; Kristensen et al., 2011). Therefore, feed management is of great importance. Thus, Jonker et al. (2002) have shown that milk yield and N efficiency were increased when farms introduced weekly or monthly determination of roughage DM content compared with farms with less-frequent determination.

The Nordic feed evaluation system (**NorFor**) is a nonadditive, net-energy system (Volden, 2011) that also balances the protein supply according to the absorption of amino acids in the intestine and supply of protein to the rumen. The output from NorFor is the expected intake of individual feeds or TMR, defined by specific feeds, and the expected milk production in kilograms of ECM and live weight change per day according to stage of lactation. NorFor has been incorporated into the dairy management system developed in recent years in Denmark and adopted by dairy-farm advisors (DLBR, 2014). The dairy management system includes several tools with specific aims: NorFor-Plan for economic optimization of the daily feed ration and individual intake, and NorFor-Control for evaluating the actual feeding and production, including efficiency of production, energy, and nutrients at herd or group level.

Jersey is the second-most-common dairy breed in Denmark, making up 13% of the dairy stock in Denmark, whereas Holstein-Friesian is the most dominant breed at 70% of all dairy stock (RYK, 2013). Based on annual results from commercial dairy herds, Kristensen and Kjærgaard (2004) found a higher net energy efficiency (energy requirements/energy intake) for Jersey herds than for Holsteins, using the Scandinavian Feed Unit (**SFU**) system (Weisbjerg and Hvelplund, 1993) to calculate net energy intake from DMI, and a higher efficiency in herds managed organically rather than conventionally. Nitrogen efficiency is also higher for Jerseys than for Holsteins, but annual milk yield per cow and energy efficiency, rather than breed, are the main explanatory factors for this difference in N efficiency (Nielsen and Kristensen, 2001). In earlier studies, Jersey cows have been shown to have a higher intake capacity per kilogram of live weight than Holstein-Friesians (Oldenbroek, 1988), which was confirmed in a newer study with primiparous cows by Olson et al. (2010). This could be part of the reason why Prendiville et al. (2009) found that Jerseys have higher gross energy efficiency (milk solids/DMI) than Holsteins, despite a lower milk-solid production. Milk yield across systems and breeds has been increasing, from 7,900 kg of ECM in 2004 (Kristensen and Kjærgaard, 2004) to 9,500 kg in 2010 (RYK, 2013). The former results were based on data from an entire dairy herd over 1 yr and use of the SFU system. The treatment of breed effect, as affected by cow weight and feeding level, in the NorFor system differs from the SFU system. A comparison based on information from only the lactating cows might change the conclusions because DIM and parity have an effect on energy balance (Olson et al., 2010).

The objective of this paper was to compare efficiency measures, milk production, and feed intake for lactating cows in commercial herds using different breeds and production and milking systems to supply dairy farmers and the extension service with updated information and benchmarking figures for feed intake, production, and efficiency in the dairy herd.

MATERIALS AND METHODS

Feeding plans and evaluation of feeding in dairy herds made by the extension service in Denmark are uploaded into a central database (DLBR, 2014), allowing the compilation of a large number of data representing dairy farming in Denmark. For the present work we used all feed evaluations recorded for the lactating cows in the period November 2012 to April 2013, which, after filtering, resulted in 1,389 recordings, representing 779 herds, or 25% of all herds with milk records in Denmark (RYK, 2013). Only the last recording for each herd was used to avoid replicates for farms. All herds were fed either a total mixed or partial mixed ration. The cows were housed in loose housing systems, typically cubicles with slatted floor, and milked in either a parlor milking unit or an automatic milking system (**AMS**). More detailed information about milking and housing was not available. In a milking parlor system, cows are typically milked twice a day, but some herds might have been milked 3 times, whereas the typical milking frequency in an AMS is 2.6 to 3.0 times a day (Bossen and Sigurdsson, 2013). Of the herds, 10% were organic certified, which includes use of organic-produced feed of which 60% of DMI has to be roughage.

Information on feed intake was based on daily consumption of concentrates at the feeding stations or AMS, calculated from the daily amounts (kg) of feedstuffs offered to the lactating cows (measured by scale at the mixer wagon), and corrected for leftovers. Dry matter and nutrient contents of each feed item were primarily based on feed analysis and second on standard table values (www.norfor.info). The expected feeding value of the ration, taking into account the actual DMI, was calculated by the Nordic feed evaluation system (NorFor) and expressed in megajoules of NE_L, whereas the feeding value of a single feed item was expressed in megajoules of $\mathbf{NE_{20}}$, based on the net energy content at a standard intake of 20 kg of DM. In addition, NorFor calculated nutrient content, protein value, fill value,