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Short communication: Genetic analysis for fertility traits of heifers and cows from smallholder dairy farms in a tropical environment

S. Buaban,*1 M. Duangjinda,† M. Suzuki,§ Y. Masuda,§ J. Sanpote,* and K. Kuchida‡
*The Bureau of Biotechnology in Livestock Production, Department of Livestock Development, Pratumtani 12000, Thailand
†Department of Animal Science, Khon Kaen University, Meaung, Khon Kaen 40002, Thailand
‡Department of Animal and Food Hygiene, and
§Department of Life Science and Agriculture, Obihiro University of Agriculture and Veterinary Medicine, Inada-cho, Obihiro, Hokkaido 080-8555, Japan

ABSTRACT

The objective of this study was to estimate genetic parameters for various fertility traits on Holstein upgraded dairy heifers and cows in a smallholder system under tropical conditions using data sets from the Thailand national recording scheme. The investigated traits were age at first service (AFS), age at first calving (AFC), days from calving to first service (DTFS), days between first and last service (DFLS), days open (DO), calving interval (CI), number of services per conception (NSPC), and conception at first service (FSC). The data consisted of 68,555, 34,401, and 54,004 records on heifers, primiparous, and multiparous cows, respectively, calving between 1996 and 2011. Gibbs sampling was employed to obtain (co)variance components using both univariate and bivariate analyses with linear and threshold animal models. Virgin heifers had better fertility performance than primiparous and multiparous cows. The reproductive performance in primiparous cows was inferior compared with multiparous cows. Cows with higher Holstein-Friesian blood showed lower reproductive efficiency. Estimated heritabilities for most of the fertility traits were 0.04 or less except for AFS (0.26) and AFC (0.25). The estimated genetic correlations among fertility traits within parity indicated that selection for cows with high conception rate could lead to shortened DO and CI, as well as DTFS. The FSC and NSPC could be used as the best indicators for heifer and cow fertility and could be complemented by other traits, which were genetically considered as different traits such as DTFS and DFLS in terms of a fertility index. This would enable efficient selection for better fertility. Genetic correlations for fertility traits in primiparous and multiparous cows were very high (>0.90), but those between heifers and cows were lower (0.03 to 0.83). The latter results indicated that fertility traits of heifers and cows should be considered as different traits.

Key words: Holstein upgraded, genetic parameters, reproduction, tropics

Short Communication

Demand for dairy products is rapidly growing in Asia, Africa, and Latin America, induced by urbanization and preferences for nutritious foods (Guyomard et al., 2013). Typical dairy system in these regions is based on low-input, smallholder farming in a tropical environment. An increase of milk production is expected to supply the demand as well as to raise the income of dairy farmers. Genetic improvement of the dairy cattle, along with changing feeding practices, is shown to greatly increase milk production (McDermott et al., 2010). Crossbreeding of local breeds with temperate dairy breeds, such as Holstein-Friesian (**HF**), has been recommended to achieve both high productivity and resistance to heat stress (Philipsson, 2000). However, cattle with high proportions of exotic temperate blood tend to be managed intensively. Additionally, these exotic breeds are by definition not well adapted to the local climate, feed resources, and management systems and require some level of environmental modification (such as cooling and ventilation system) to remain reasonably healthy and productive (Herath and Mohammad, 2009).

Thailand, as a tropical country, is located between 5°35′ and 20°30′ N and 97°20′ and 105°40′ E. Annual temperatures typically range from 19 to 38°C (66 to 100°F), relative humidity ranges from 66 to 81%, and rainfall ranges from 201 to 2724 mm. Thailand has 3 seasons: summer (March–June), rainy season (July–October), and winter (November–February; Meteorological Department, 2013). The dairy cattle population reported in 2013 consisted of 512,205 animals with 229,899 cows on 17,094 farms (Department of Livestock

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[1]Corresponding author: buaban_ai@hotmail.com

Development, 2014), and raw milk production was approximately 1,067,452 t per year (Office of Agricultural Economics, 2014). The majority of dairy farmers (80%) are smallholders with an average of 30 animals per farm (calves, heifers, and cows). Most of the dairy cows are crossbred from *Bos indicus*, such as Sahiwal, Brahman, and Thai Native cattle upgraded by HF. Currently, the majority of the dairy population has >75% HF blood. Average milk yield per cow is 4,000 kg per lactation. Generally, no cooling devices are available in the barns. More than 90% of dairy cattle are subjected to AI services provided by a government organization (Department of Livestock Development, Thailand), and the rest are serviced by a semi-government organization (Dairy Promotion Organization, Thailand) and the dairy cooperatives in the areas. Frozen semen used for AI services is both imported and produced locally. The AI records of dairy cattle have been collected in the database system by AI technicians since 1996. The daily feed ration is based heavily on concentrates. Roughages commonly used consist of tropical grass, rice straw, and some agricultural wastes. The ingredient composition of the concentrate feed depends on local availability and price. However, shortages of roughage are serious in winter and summer, and farmers have to buy hay or rice straw or increase their use of commercial mixed rations.

The dairy cattle in Thailand have been developed through the national sire selection and AI mating program since 1956, focusing on milk production. Continuous increasing milk yield by selection has induced a decrease in reproductive performance (Pryce and Veerkamp, 2001) due to the antagonistic genetic relationship between milk yield and fertility traits (Roxstrom et al., 2001; Liu et al., 2008). In particular, during early lactation in high yielding cows, dietary intake of cows fails to keep pace with the demand for peak milk production (Bauman and Currie, 1980), leading to negative energy balance, which has serious consequences on other body functions (Banos et al., 2006; Løvendahl et al., 2010). The inclusion of fertility in the breeding goal is necessary to optimize the result of genetic improvement of dairy cattle.

The reproductive performance of dairy cows under smallholder conditions in Thailand from 2001 to 2005 was studied and reported by Leelasiri et al. (2006). The averages of days from calving to first service (**DTFS**, d), days between first and last service (**DFLS**, d), days open (**DO**, d), number of services per conception (**NSPC**, no.), and calving interval (**CI**, d) were 86.50 ± 0.12, 23.33 ± 0.02, 127.99 ± 0.23, 1.89 ± 0.00, and 410.14 ± 0.23, respectively. Research on genetic studies of fertility traits in tropical conditions, including Thailand, is very limited, but data sets are available from a few herds (e.g., Demeke et al., 2004; König et al., 2005; Estrada-León et al., 2008).

The objective of this study was to estimate genetic parameters for various fertility traits on crossbred dairy heifers and cows in a smallholder system under tropical conditions, using AI data from the national recording scheme.

Data of pedigrees, breeding records, calving information, and lactation information of Thai dairy cattle, calving between 1996 and 2011, were obtained from the dairy cattle database of the Bureau of Biotechnology for Livestock Production, Department of Livestock Development, Thailand. The investigated traits were age at first service (**AFS**, mo), age at first calving (**AFC**, mo), DTFS, DFLS, DO, CI, NSPC, and conception at first service (**FSC**). The NSPC and FSC were considered as ordered categorical and binary traits, whereas the DTFS, DFLS, DO, and CI were determined as continuous traits (time interval traits). The traits recorded from birth to first calving were considered as heifer traits. Traits measured on first-lactation animals were considered as primiparous cow traits, and the traits measured from second to fifth lactation were considered as multiparous cow traits. Therefore, AFS and AFC were considered as specific traits for heifers, whereas DTFS, DO, and CI were considered as specific cow traits. The DFLS, FSC, and NSPC were defined for both heifers and cows. A conception for a heifer or a cow in a specific parity was determined with subsequent calving data that got along with the latest insemination data. A subsequent service within 10 d from previous insemination was considered a double insemination, and was discarded. Animals with complete records were included in the analysis if at least one contemporary mate was present in a herd-year of first service subclass for heifers, and a herd-year of calving subclass for cows. The sires for heifers and cows in the data set were identified.

The final edited data sets for univariate analyses and bivariate analyses within parity included 68,555, 34,401, and 54,004 fertility records for 68,555 heifers, 34,401 primiparous cows, and 34,400 multiparous cows (1.57 records per cow), respectively. The data of primiparous cows were fewer than heifers in this population because some farmers have limited capacities such as land and funds, so they sold the pregnant heifers to other farms that are not under the Department of Livestock Development database system. For bivariate analyses across parity, the data sets consisted of 20,433, 16,986, and 16,107 animals for heifers-primiparous cows, heifers-multiparous cows, and primiparous-multiparous cows, respectively. For univariate and bivari-