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Review article

Challenges facing the development of a genetic improvement program for dairy cattle in Myanmar

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Abstract

Myanmar is the second largest agricultural-oriented country in Southeast Asia. Cattle in Myanmar are mostly for draught, with only 1% for dairy. Myanmar local breeds originated from Zebu (*Bos indicus*). Thus, they are well adapted to tropical environmental conditions and are resistant to tropical diseases and external parasites. However, the milk production of local breeds is low. Consequently, local dairy cattle have been crossbred with genetically improved dairy breeds to increase the milk yield. Achieving high milk yields quickly has been a major goal of dairy farmers and has been strongly supported by the Myanmar government. Primarily, foreign aid projects in Myanmar have focused on upgrading local dairy cattle to *Bos taurus* improved dairy breeds using artificial insemination. However, imported germplasm should be genetically evaluated under local conditions at the farm, regional and national levels to identify the most suitable animals under Myanmar's production and environmental conditions. This will require the implementation of a national information-based selection and mating program accompanied by cost-effective management and feeding systems. At present, individual pedigree and performance records are largely unavailable in Myanmar. Thus, there is a need for a comprehensive national dairy cattle improvement program encompassing an individual animal database, genetic evaluation, and selection and mating plans that should be devised, tested and implemented.

Introduction

Myanmar is a member of ASEAN (the Association of Southeast Asian Nations) in the list of developing countries whose national economy is largely based on agriculture and livestock farming, with livestock representing a large portion of Myanmar's Gross Domestic Product and contributing to food security by providing meat, eggs and milk (European Chamber of Commerce in Myanmar, 2018). The cattle population in Myanmar is estimated to be 9.7 million, with 0.12 million dairy animals and 9.62 million draught animals (Livestock Breeding and Veterinary Department, 2018). Most cattle are raised under tropical conditions characterized by high temperatures and humidity.

The Myanmar government introduced exotic cattle breeds to improve indigenous cattle by genetic upgrading (Pham et al., 2015). In 1952–1953, the Agriculture and Rural Development Cooperation program under the Ministry of Agriculture took responsibility for the improvement of draught animals and dairy farming by setting up a model farm in the township of Taungdwingyi, where artificial insemination (AI) with fresh semen was introduced. This AI service could not be extended nationally at that time and only covered areas where dairy products were in high demand. In

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1958, the AI service was reintroduced at the "Government 9th Miles Farm" (National Consultative Committee, 2002). That year, Indian breeds such as Red Sindhi and Thari were imported from Pakistan (Myint et al., 2018). In June 1978, a project funded by a loan from the World Bank permitted the importation of 129 pregnant heifers (67 Friesian and 62 Jersey) from New Zealand. In addition, 79 pregnant heifers and 2 bulls were imported from Australia as part of an UNDCP project (Myint et al., 2018). The importation of animals from high-performance exotic breeds was aimed to improve the dairy merit of tropically adapted indigenous cattle. National Consultative Committee (2002) indicated that the purpose of the distribution of large amounts of Holstein semen was to upgrade the Myanmar dairy cattle population to a Holstein percentage between 50% and 75%.

Milk production of local indigenous cattle is lower than that of improved foreign breeds because of their genetic characteristics, limited availability of feed, and traditional management system. Myanmar local cattle originated from Zebu (*Bos indicus*), which is well adapted to tropical environments and they are resistant to tropical diseases and external parasites (Herring et al., 2018). There is a variety of local breeds of cattle throughout the country (Livestock Breeding and Veterinary Department, 2018) and most of them are primarily used as draught animals (Pham et al., 2015). The dairy population of Myanmar contains various distinct types of crossbreed cattle whose milk performance is determined by both additive (breeding value, transmissible) and non-additive genetic effects (heterosis, not transmissible). These distinct types of crossbred animals respond differently to the tropical environmental conditions and the variety of management systems and nutritional regimens existing in the country. Currently, Holstein crossbreds are the preferred type of cattle because of their high milk yields and their reasonable adaptability to local environmental conditions (National Consultative Committee, 2002; Livestock Breeding and Veterinary Department, 2016). Animals of all straightbred and crossbred types need to be genetically evaluated and selected for milk yield under existing nutritional and management conditions and prevailing external parasites such as ticks and flies. This needs to be accompanied by an increase in understanding of good management, nutrition, and health dairy farming practices. To help identify and correct gaps in Myanmar dairy operations, individual farmers will need to collect information on dairy farming practices and individual performance of all cattle in their farms.

The Myanmar dairy sector is currently in the early developmental stage due to limitations of knowledge, skills, facilities and data recording systems. During 2010 and 2011, 18,081,000 kg of sweetened condensed milk were imported from Singapore, Malaysia and Thailand, 5,081,000 kg of milk powder were imported from New Zealand, Singapore, Malaysia and the Philippines and 18,577,000 kg of evaporated milk were imported from Singapore and Malaysia (Hinrichs et al., 2014). These large amounts of dairy imports emphasized the existence of a high demand for milk and dairy products. Condensed milk consumption has gradually increased at local cafeterias throughout the country and although condensed milk is produced by local dairy farms, the current level of production is insufficient to meet demand (Lee et al., 2014). During 2013 and 2014, the Ministry of National Planning and Economic Development reported that Myanmar produced the equivalent of 1.9 million t of milk (Lee et al., 2014). According to a 2014 survey, eight dairy processing plants producing pasteurized milk and dairy products such as yoghurt and butter were established by private owners in Yangon with a further seven in Mandalay (Lee et al., 2014). Food safety and the quality of the dairy products will determine the level of increase in income and sustainability of local dairy producers. A major challenge will be to increase milk production and efficiency by means of better genetics, nutrition and management. To meet the current and future demands for milk and processed dairy products, Myanmar needs a comprehensive and sustainable national dairy cattle improvement program. This study considered the current situation and challenges facing this country to develop an efficient and sustainable dairy improvement program encompassing an individual animal database and associated genetic, selection and mating programs.

Geography

Myanmar is located in Southeast Asia between 9°58'N and 28°29'N and between 92°10'E and 101°10'E. The country shares borders with India and Bangladesh to the north west, with Thailand to the south east, with Laos to the east and with China to the northeast (Fig. 1). The total land area of is 676,577 km^2 and the length of the international border is 5,858 km (National Consultative Committee, 2002). The capital city is Nay Pyi Taw, and the most populated cities are Yangon and Mandalay, where many privately-owned dairy farms have been established.

The following climatic data have been sourced from Aung et al. (2017). Myanmar is in a tropical monsoon region with three seasons: summer (March to mid-May 32°C to 40°C), rainy (mid-May to October 25°C to 30°C) and winter (November to February 20°C to 24°C. The average annual rainfall is about 5,080 mm in the coastal

Fig. 1 Map of Myanmar (Australian National University, 2019)

region of Rakhine and Taninthary, and 2,540 mm in the low land of the deltaic areas. Northern Myanmar is the coolest region with an average temperature of approximately 21°C. The coastal and delta regions have maximum temperatures of approximately 32°C. Seventy percent of the population live in rural areas where farmers produce the vast majority of cattle, buffaloes, sheep, goats, pigs, chickens and ducks in small-scale family operations for their own consumption and personal income. Larger commercial operations of dairy cattle, pigs, layer hens and broiler chickens utilize intensive systems and are owned by city dwellers (Livestock Breeding and Veterinary Department, 2018).

Cattle

Cattle in Myanmar are raised under tropical climatic conditions. They are mainly used for draught power in mixed crop-livestock systems (Pham et al., 2015). Traditionally, calves are kept with their dams until weaning. Heifer calves are mainly reared as replacements while most bull calves are sold for meat at about age 7–8 mth or used for draught, while a small percentage of bulls are kept as sires for breeding purposes (National Consultative Committee, 2002).

Local breeds of cattle include "Shwe Ni", "Pyar Sein", "Ngwar Pyar Ni", "Shan Ngwar Pu", "Katonta", "Kyauk Phyu", "Yenbye" and "Kadarta" (Fig. 2; National Consultative Committee, 2002, Lwin et al., 2018). Among these, "Shwe Ni" and "Pyar Sein" are the best-known breeds. The "Shwe Ni" is an indigenous breed and the "Pyar Sein" is a cross between Indian and indigenous Myanmar breeds (Myint et al., 2018). "Shwe Ni", named because of its reddish color, is used as a draught beast in farming operations (Herring et al., 2018). This breed is predominantly seen in the central dry areas of the Sagaing, Mandalay and Magway regions. The "Pyar Sein" breed, produced by crossbreeding between Indian and local Myanmar breeds, is present in dry areas and the northern region; its coat color is predominantly gray and it is used for both draught and milk production (Pham et al., 2015).

Local Myanmar breeds produce lower quantities of milk per year than imported breeds such as Holstein Friesian, but they can tolerate well the stressful environmental conditions. Therefore, to increase milk production, the Myanmar government has been officially supporting an artificial insemination service for small- and large-scale dairy producers to upgrade local cattle with imported and locally produced Holstein frozen semen. Currently, a large number of cattle in Myanmar are crossbreds between Holstein Friesian and local breeds; these crossbreds are preferred because of their high milk production (Lwin et al., 2018). However, progress has been slow and nationwide changes in dairy production have been minor.

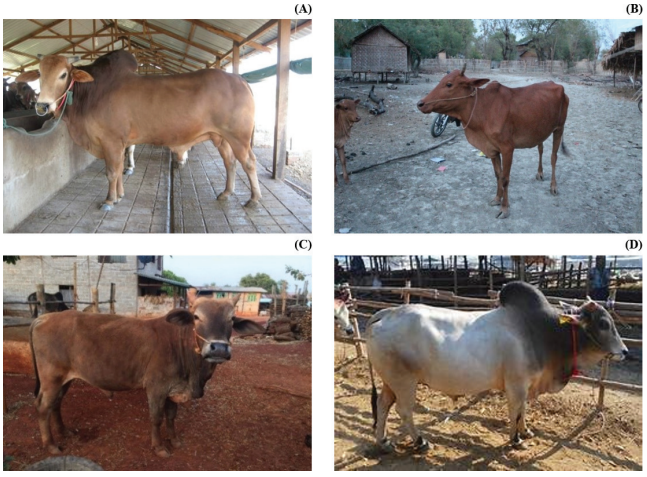

Fig. 2 Myanmar local cattle breeds: (A) Shwe Ni, (B) Shan Ngwar Pu, (C) Ngwar Pyar Ni, (D) Pyar Sein

Milk production

Dairy farms in Myanmar can be classified into small scale (less than 100 cows), medium scale (100 to 200 cows), and large scale (more than 200 cows). Milk production varies due to farm size, farm location, farmer labor skills, nutrition and management. Farm size can be the defining factor of the production system utilized in dairy farms (Rhone et al., 2007). Small-scale farms rely mostly on Holstein Friesian crossbreds and constitute most dairy farms in Myanmar. Small-scale farms utilize only family labor and are called specialized family farms (Lee et al., 2014). These farms are low-input, low-output operations that provide cows with low quality feedstuff such as rice or wheat straw, corn stalk, peanut residues and roadside grasses. This conventional husbandry system requires minimal labor input as cattle are left to graze on pastures on farms, communal land and roadsides (Pham et al., 2015). Cows in these farms tend to have low milk yields and short lactations because of insufficient water and good quality forage (Aung et al., 2016). The main barriers limiting the development of the Myanmar dairy sector have been urbanization, lack of technical knowledge and laboratory facilities, land use policy, consumption habits, cattle genetic ability and competition with imported dairy products (Lee et al., 2014).

Other common pest and diseases causing low milk production are mastitis, insects, external parasites and heat stress (Lee et al., 2014). Mastitis decreases the quality and quantity of milk and adversely affects animal health. This disease is mainly caused by bacteria via contamination at the tip of the teat, followed by an increase in bacterial concentration and an inflammatory response in the mammary gland. Poor milking practices and inappropriate maintenance of milking equipment (vacuum pumps, air pressure, liners) could also contribute to the existence of mastitis and its spread within the herd (Jones et al., 2009). In addition, insects such as stable flies, house flies, black sucking flies, lice, ticks and mites lower milk production and are major causes of health problems. The prevalence of parasitic infections (external and internal parasites) differs across geographic locations; however, most dairy farmers use traditional control measures although they are aware of the need for regular deworming programs (Lee et al., 2014).

Dairy production systems

Myanmar has three dairy cattle production systems: 1) a low-intensity indigenous cattle system, 2) a low-intensity Holstein Friesian crossbred system and 3) a high-intensity Holstein Friesian crossbred system. Feeding practices in these systems include roughage and concentrate. Animals are either fed grass from the farm or which has been purchased using a cut and carry system or animals graze on road-side pastures and pastures from communal lands (Hinrichs et al., 2014). Most of these activities are low input using only family labor and relying on low quality feeds such as rice or wheat straw, corn stalks and peanut residues, though common sources of concentrate in high intensity herds are cotton seed cake, sesame cake, rice powder, bean powder, rice bran and brewer's grain (Aung et al., 2016). Farmers

with sufficient farmland grow forage crops for cattle feeding. Grasses suitable for Myanmar's soil and weather conditions include Napier (*Pennisetum Purpureum*), Mulato (a *Brachiaria ruziziensis* × *Brachiaria brizantha* cv. Marandu hybrid), Mombasa *(Panicum maximum*), Para grass (*Brachiaria mutica*) and Ubon Paspalum (*Paspalum atratum*). Thirteen types of legumes grow widely in the different agroclimatic areas of Myanmar, with the most common being black gram (*Vigna mungo*), mung bean (*V. radiata*), pigeon pea (*Cajanus cajan*), and soybean (*Glycine max*) and their crude protein content is in the range 20–28% (Han et al., 2001). Forage production is lower in the summer because of a shortage of water and high ambient temperatures and during this time, dairy farmers supplement cows with urea-treated rice straw, crops and agricultural byproducts such as rice, maize, sunflower, groundnut and wheat (Lee et al., 2014).

Milk production levels largely depend on the production system. In low-intensity Holstein Friesian crossbred systems, average milk production is 4 kg per cow per day and age at first calving is 3 yr with a maximum of 6 lactations by age 10 yr and a length of calving interval of about 18 mth. Hence, milk production per cow from local breeds under low-input low-output feeding conditions is in the range 400–800 kg per lactation. However, with better management, feeding and water milk production per cow could increase to 1,500–2,000 kg per lactation (Lee et al., 2014). In high-intensity Holstein Friesian crossbred systems, daily milk production is 7–11 kg per cow or 2,530 kg for a 300 d lactation period. The standard first calving age is 24 mth and the calving interval is in the range 12–18 mth (Hinrichs et al., 2014).

The total amount of milk produced in Myanmar increased 139,250 kg per year from 2013 to 2016 (Fig. 3; Naing et al., 2019). Some of the fresh milk produced is for a school milk program supported by the Myanmar government with help from the Food and Agriculture Organization of the United Nations (FAO) (Hinrichs et al., 2014). Most commercial farmers in Myanmar milk twice a day (early morning and late afternoon) using a milking machine or manually (Lee et al., 2014). Milk quality is one of the primary concerns of dairy operations. The market value of milk depends on geographic location, market demand and quality (fat, protein, solids nonfat, lactose, total solids). The percentage of water added to the milk is checked using a lactoscan (Hinrichs et al., 2014) and milk is rejected if the added water percentage is greater than 3%.

Milk consumption habits

Milk consumption varies widely in Myanmar. Lee and Jong (2014) evaluated the status and business opportunities of the Myanmar dairy sector. They reported that people living in large cities regularly consume dairy products such as fresh milk, yogurt, butter, cheese and sweetened condensed milk. Conversely, people from rural areas rarely consume fresh milk. However, large quantities powder and condensed milk are used in combination with coffee and tea. There are 135 tribes living in Myanmar, each with its own religious beliefs and the people from each tribe have their own unique lifestyle. Every township, village and ward has its traditional style tea shops (cafeteria). Thus, large quantities of powder and condensed milk are imported from abroad. Pasteurized milk is available in supermarkets in plastic bottles or plastic bags in a size range of 220–2,000 mL (Hinrichs et al., 2014). The amount of milk consumed per capita increased from 26.7 kg in 2007 to 46.8 kg in 2015, or 5.03 kg per year (Fig. 4, Livestock Breeding and Veterinary Department, 2016; Naing et al., 2019). Although pasteurized milk is available in supermarkets, few people understand that milk is pasteurized for health safety reasons, with many assuming that pasteurized milk is only for elderly people and infants (Hinrichs et al., 2014). They prefer to consume yoghurt with sugar and fruit. Ready-made yoghurts are widely available in Yangon and Mandalay markets. Domestic milk processors have already entered this market; however, the majority of their products have no official certification of safety (Lee et al., 2014). This means that unless Myanmar milk processors obtain an official certificate of accreditation issued by the Food and Drug Agency, they will not meet the minimum standards required by ASEAN country members and consequently they will be unable to sell their products in public supermarkets (Hinrichs et al., 2014).

Dairy genetic improvement programs

Dairy genetic improvement programs in Myanmar are still under development (Lee et al., 2014). The primary goal of dairy producers is to generate higher returns from their dairy operations. This could be achieved with crossbred cattle having a high Holstein percentage, provided that they are managed appropriately and receive a sufficiently high level of nutrition to express their genetic potential. There are three main organizations pursuing improvement of dairy cattle and milk production in Myanmar: the Livestock Breeding and Veterinary Department (LBVD), the Myanmar Livestock Federation and the Myanmar Dairy Association. The major responsibilities of LBVD are to preserve and genetically improve existing indigenous breeds of livestock, undertake disease control, improve animal health, and upgrade draught and dairy cattle. In addition, they conduct training and extension services for departmental staff and private farmers

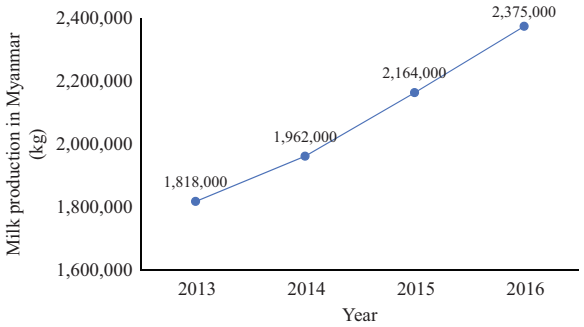

Fig. 3 Milk production in Myanmar

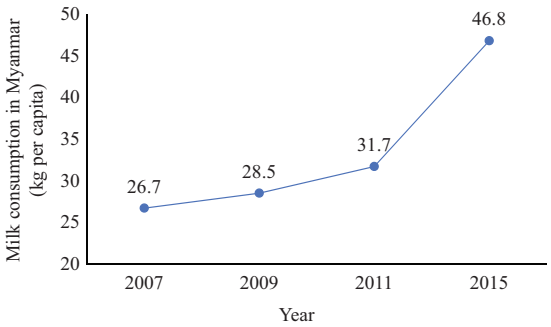

Fig. 4 Milk consumption in Myanmar

and monitor and evaluate live animals as well as the exportation and importation of animal products (National Consultative Committee, 2002).

Historically, dairy farming was introduced in Myanmar in 1970. A World Bank project imported frozen semen (150,000 doses) from North America and Europe to Myanmar between 1976 and 1981 to genetically improve local Myanmar breeds, particularly for milk production (Than Hla et al., 2001). After the World Bank project ended in 1981, imported frozen semen was replaced with local frozen semen (Than Hla et al., 2001). Subsequently, other exotic breeds were introduced to improve beef and milk production through upgrading and crossbreeding mating programs. Dairy farmers progressively realized the importance of dairy genetic improvement programs in ASEAN countries. In 1990, artificial insemination services in the dairy sector abruptly declined because of a shortage of liquid nitrogen. At approximately the same time, interest in dairy farming decreased due to the unavailability of modern technology that could have been used to resolve the production problems. Starting in 2000, LBVD reinvigorated the dairy sector by providing dairy farmers with updated information on good farming practices and value-added products and commenced operating two liquid nitrogen plants (at Yangon and Nay Pyi Taw). This has allowed commercial dairy farmers to use frozen semen from the United States of America, Germany, New Zealand and Thailand but demand has exceeded supply. Dairy farmers prefer Holstein Friesian (HF) to other breeds because of its high milk yield. However, LBVD produces frozen semen from only a limited number of HF sires. Estimated breeding values for dairy cattle computed using pedigree and performance records collected in Myanmar are currently unavailable. Thus, most dairy farmers purchase frozen semen based on pedigree or type information provided by veterinarians, inseminators or based on their own experience and perhaps information from other dairy farmers. Small-scale farmers use mainly local bulls for breeding their cows even if genetic information on these bulls is not available (Lee et al., 2014).

Nearly all small-scale dairy farmers have neither pedigree nor performance records on individual dairy cattle. Some farmers keep pedigree records and records of mating and milk volume per farm, but most of these records are incomplete and do not follow a regular schedule. Thus, the lack of individual animal records prevents the development of progeny testing programs and severely limits genetic improvement. The LBVD has outlined a vision and a mission for the improvement of the dairy sector through a public awareness campaign, selection of the most suitable bulls and the establishment of good husbandry practices. It has also been involved in various international collaborations over the years. In 1999–2001, LBVD and Japanese scientists launched a research collaboration to study the genetic properties of native livestock in Myanmar (National Consultative Committee, 2002). Similarly, a FAO project was conducted to conserve Shwe Ni Gyi cattle in central Myanmar (National Consultative Committee, 2002). Recently, LBVD received funds from the New Zealand Government to launch a small-scale dairy development project using modern feeding strategies (Freeman et al., 2018). This also provides frozen semen of New Zealand bulls free of charge and contributes technical consultants on dairy farming. The aims of this project are to increase milk production (*via* improvements in feeding and management), to provide laboratory equipment to test for milk quality, and to increase the consumption of milk and dairy products in Myanmar (Freeman et al., 2018).

The Myanmar Dairy Excellence Project from the Ministry of Foreign Affairs and Trade, initiated in 2014 with funds from the New Zealand Aid Program, supplied 5,000 semen straws of 100% Friesian and 500 straws of Kiwi cattle as well as consultants and technical advice for dairy farming (Freeman et al., 2018). The Department of Livestock Development and the Dairy Farming Promotion Organization from Thailand provided frozen semen of beef (100,000 straws) and dairy (20,000 straws) breeds to the Myanmar government in 2016. In addition, hands-on training in dairy genetic improvement programs, mating plans, performance tests, progeny tests and genetic evaluation have been provided periodically to Myanmar dairy producers and officers of LBVD. At present, LBVD is increasing the production of frozen semen with the aim of expanding its services to all dairy farmers across Myanmar (Livestock Breeding and Veterinary Department, 2018).

Commercial dairy production in Myanmar began over a decade ago. However, individual pedigree and performance data are largely unavailable although dairy producers have been advised to keep these records as a part of various dairy improvement programs. This lack of animal performance and dairy farming data has prevented the implementation of genetic evaluation and selection programs. Pedigree and performance records of evaluated animals are crucial for dairy genetic evaluation, selection and mating programs (Weigel et al., 2017).

A sustainable program to improve the productivity of the dairy sector in Myanmar would require the development of a national individual animal database with pedigree and performance records from all animals in the herds, regardless of breed composition or whether they were to be kept as replacements or subsequently sold. Farms of all sizes from across the country need to participate. Production and reproduction traits need to be evaluated, and selection and mating plans should have clear objectives. Expected progeny differences (EPDs) or estimated breeding values (EBVs) would be computed for all animals in the population and subsequently used to perform selection and mating plans aimed at increasing performance, efficiency and the sustainability of dairy operations.

Once laboratory facilities can be provided or the cost of DNA genotyping becomes more affordable, perhaps research and development efforts towards the implementation of a genomic information system could be integrated into a national genetic evaluation program. Genomic research will provide needed information on the importance of genes associated with economically important dairy traits under local environmental conditions. Combining individual pedigree, phenotype, and genomic information will improve the accuracy of genomic-estimated breeding values, which in turn will increase the speed of genetic improvement for economically important traits (Koonawootrittriron and Elzo, 2010; Wongpom et al., 2019). However, training of dairy producers on recording and utilization of data for genetic, production, economic improvement purposes would likely be the most challenging aspect facing the implementation of a national dairy genetic improvement program in Myanmar. This aspect could be aided by the development of a national consortium involving dairy producers, universities and government research institutes involved in dairy research and development. The consortium would help focus the various dairy-related efforts toward the development of a national research and development initiative that could include a DNA repository, a database with pedigree, phenotypes and genotypes, and software for genomic evaluation, selection, mating plans, and economic evaluation of the implemented technologies.

Conclusion

Myanmar is a developing country in tropical Southeast Asia. The demand for milk consumption within the country has gradually overtaken local production supply. Commercial dairy operations rely largely on upgraded cattle (to breeds such as Holstein Friesian) because their milk yield is higher than that of local cattle. However, there is a dearth of individual pedigree and performance records for dairy genetic and management improvement programs. Thus, there is a need for a comprehensive national dairy cattle improvement program encompassing an individual animal database, genetic evaluation, and selection and mating plans that should be devised, tested and implemented to increase the performance, efficiency and sustainability of the dairy industry in Myanmar.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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