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Review

Review on breeding objectives and practices of dairy cattle production in Ethiopia

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The review aims to examine dairy cattle production system together with pastoral and agro- pastoral, small holder, peri urban and urban intensive dairy cattle production system, breeding practice including mating system (natural mating and Artificial Insemination), breeding objectives, reproductive and productive traits of dairy cattle in Ethiopia. In Ethiopia most farmers use natural, unplanned and uncontrolled mating system by using breeding from communal grazing and a few farmer use AI for improvement of breed and production by upgrading the genetic makeup of indigenous breed of cattle. Hence in Ethiopia, using breeding objectives in line with the effective breeding policies for both natural service and AI for sustainable and effective animal breeding practice is needed. Stakeholders, animal breeders and policy designers are to pay attention in transforming the already existing traditional breeding practices that target the productivity of dairy cattle with cautious consideration of genetic conservation of local cattle breeds.

Key words: Breeding objective, breeding practice, dairy cattle, Ethiopia.

INTRODUCTION

The major economic activity of Ethiopia is agriculture. Livestock sector being part of agricultural activities plays an important role in the social, cultural and economic development of the agrarian community. Ethiopia is ahead of other African countries holding the largest livestock population estimated to be 59.5 million heads of cattle, 30.7 million sheep, 30.2 million goats, 8.43 million donkeys, 2.158 million horses, 0.409 million mules, 1.2 million camels, 59.49 million chicken and 5.90 million beehives (Central Statistical Agency (CSA, 2016/2017). While livestock sector is mostly of smallholder farming system having several purposes, hitherto contributes about 15% of export earnings, 16.5% of the national GDP, 30% of agricultural employment and 35.6% of the agricultural GDP (Duressa et al., 2014; Metaferia et al., 2011). Livestock contribute an important nutritional supplement to groups that are vulnerable, boost the pliability of smallholder households in time of shortage of food and help in the maintaining of traditional social safety nets (Randolph et al., 2007). The sub-sector plays an important role in contributing to the national economy thereby generating income for farmers, providing opportunities for job, ensuring food security, providing services, contributing to cultural, social, asset and environmental values, and sustaining livelihoods (Solomon, 2003; Sintayehu et al., 2010; CSA, 2017).

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Dairy sector is an important part in the socio-economic standing of sub-Saharan Africa (SSA); including Ethiopia for playing their role both in food security and income generating roles, most importantly at the small household level. As indicated in CSA (2016/2017), most cattle in Ethiopia that are reared by the agrarian community are mostly of native breeds/ecotypes which is about 98.2 percent of the total cattle present in country level and the rest 1.62 are crossbreed and 0.18 are exotic cattle breeds. The spread of native cattle across the different agro-ecologies of the country paved way for several options of tangible and non-tangible use of livestock products to the pastoral communities and smallholder farmers (CSA, 2016/17). According to CSA (2016/17), cattle are mainly kept for milk, draught power, breeding and beef purpose, and have also high contribution of milk production performance annually with about 3.1 billion litters with 1.37 liter milk yield per day by having 6 month average lactation length per single lactation.

Though indigenous Ethiopia cattle adapt well to the tropical environment they are able to produce and reproduce under stress that is, high disease prevalence, high degree of temperature and low level of nutritional status. Their production performance was recorded to be low because of their low level of inputs, genetic make-up and traditional husbandry practice besides environmental stress (Azage et al*.,* 2010).

According to the study of Godadaw et al*.* (2015)*,* the breeding method of dairy cattle is mostly natural mating and there is also the use of Artificial Insemination (AI) in a small amount for breeding purpose and to increase the production performance of dairy cattle for the next generation. Notwithstanding the significance of this subsistence sector, very few information is made available on the position of the national dairy cattle genetic improvement program made to guide development planners, policy makers and breeders to redesign the most suitable breeding practice that can respond to the current situations in Ethiopia (Kefena et al., 2011).

Therefore it is important to review breeding practice of dairy cattle for improving the genetic vigor, production and reproductive performance of indigenous breeds by reviewing dairy cattle production system, breeding objective and practice of dairy cattle in Ethiopia.

Dairy cattle production system in Ethiopia

Most dairy cattle production system in Ethiopia depends on low producing indigenous breeds of cattle. Dairy cattle production systems already existing in Ethiopia is part of four major livestock production systems: specialized commercial dairy production systems, pastoral and agro–pastoral production, rural smallholder (mixed crop–livestock) production and urban and peri-urban smallholder dairy production.

Rural small holder (crop-livestock) dairy production system

The highlands of Ethiopia have a high prospective for dairy development residing in the central part of Ethiopia with over 40% of the country (approximately 490.000 km^2) being the largest in Sub-Saharan Africa (Tedla et al*.*, 1989). This production system mainly occurs in highland agro–ecological zone where the climate is favorable to both livestock rearing and crop cultivation. Complementary enterprises and different types of farm animals excluding camels are found with farmers preferring to preserve the mixtures of farm animal species.

Milk production in this production system depends largely on indigenous breeds and small amount in cross breeds of cattle. Therefore, most of the milking cows are indigenous animals with low production performance with an average age of first calving being 53 months while 25 months for average calving intervals of 25 months. While in the farming system, feed requirements are got from native pasture with supplement from crop residues and stub grazing.

Agro pastoral and pastoral dairy cattle production system

Agro pastoral and pastoral dairy cattle production systems are only seen in extensive lowland areas dominated by semiarid and arid agro-climates. The system is categorized by subtly pastoral rangelands that are populated, where the subsistence got is based mainly on livestock and livestock products except in agro–pastoral areas, where some of the crops are produced for both market and subsistence. In the pastoral system, big herds of cattle are grazed on public and communal land. Due to the scarcity of water and feed, cattle are trekked for long distances. Pastoralists are not able to settle or take advantage of available production technology mainly artificial insemination technology.

Sizable pieces of land are owned by agro-pastoralist where they practice integrated crop-livestock production. In the system, the crop debris is only used when there is scarcity of feed but has high nutritional deficiencies.

Livestock husbandry as seen in the system is subjugated by camels, goats, cattle and sheep and the main source of food being milk, therefore, pastoralists tend to keep large herds to ensure enough milk supply and income (IBC, 2004).

Urban and peri-urban small holder dairy production system

In general, urban dairy cattle production systems are seen in cities and/or towns for the production and sale of

milk, with little or no land resources, only making use of the human and capital resources made available mainly for specialized dairy production under stall feeding conditions (Azage et al*.,* 2013). With their location, urban producers are not foreseen to have access to agricultural or pasture land, as the operation takes place within cities and as a result, they are forced to buy feed (Zegeye, 2003). Peri-urban dairy systems are located mainly in rural areas or at the edge of the urban areas having relatively better access to urban centers in which dairy products are highly needed (Azage et al*.,* 2013).

These systems contribute enormously towards filling the large demand-supply gap for milk and milk products in urban centers where dairy products consumption is unusually very high, and are known to be the leading suppliers of raw milk to the processors of different scales (Zelalem et al*.,* 2011). Dairying practice in urban and peri-urban areas paved way for job opportunities, providing farmers with the opportunities to use labour, land and other feed resources to bring in regular income (Gillah et al*,* 2012). Urban and peri-urban being market-oriented systems emerge as a significant part of milk production systems in Ethiopia. Food and nutrition, increased income, employment generation, organic waste recycling and uplifting social status are known to be the most important benefits (Gillah et al*.,* 2012). Urban and peri-urban systems are intensified through the use of crossbred dairy cows, purchased and conserved feed and stall-feeding (Azage et al*.,* 2010).

According to Assaminew and Ashenafi (2015), the average head of crossbreed cows was very high in urban than that of peri-urban dairy cattle production system and the total cattle heads which include cross and local breeds. Similarly, grazing land holding and land allocated for forages were higher in peri-urban production system.

Commercial dairy cattle production system

This is a specialized market oriented dairy operation that is practiced by the state sector and with a few private commercial farms. Though, most of the farms are located in and around Addis Ababa, and they mostly keep exotic dairy stock (Ketema and Tsehay, 1995; Azage et al*.,* 2000).

Reproductive and productive performances of dairy cattle

Both genetic and non-genetic factors influence the reproductive as well as productive performance of animals. The reproductive performance in dairy animals affects the total milk production and calf crops that is got during the life time of dairy cows. Indigenous cattle in Ethiopia are known to the leading source of milk around the production systems excluding urban and peri-urban dairy system where crossbreeds have momentous contribution to milk production.

Dairy cattle reproductive efficiency can be measured in several traits, like age at first service, number of service per conception, age at first calving, lactation length, calving interval, days open, and average milk yield per day an per lactation.

Age at first service (AFS)

According to the study of Giday (2001), AFS is the time or age that the body condition and sexual maturity are attained by the heifers in accepting service for the first time**.** It is defined as the length of time between the date of birth and the date of showing first heat in a life time of an individual cow or heifer. According to Asefa et al. (2015), the average age at first service was 40.74 months for heifers of indigenous breed and the average effective age service of local bull is 44.4 months in Sidama zone southern Ethiopia.

On the other hand, the average age of first service for Holestain Friesian /zebu cattle cross breed in Northern Amhara was 24.8±6.6 months (Mekonnin et al, 2015). The age at first calving is lower in exotic and cross breed than indigenous breeds. Nutritional status being one of the management factors determines the pre-pubertal growth rates and reproductive development (Masama et al*.,* 2003). Economic loss is caused with the delay in the attainment of sexual maturity, due to an additional, non-lactating, unproductive period of the heifer/cow over several months (Mukasa-Mugerwa, 1989).

Genotype and agro-ecologies variation in AFS is possibly due to the effect of non-genetic factors including alteration in management and feeding systems. Shiferaw et al*.* (2003) also reported the reproductive efficiency of dairy cows that is predisposed by diverse factors, which include production system, genetic, nutrition, season, age, housing and management and environment and diseases.

Number of service per conception

The total number of service per conception is known to be the number of services/inseminations needed for a conception to be successful (Menale et al., 2011). This relies mainly on the breeding system that is being used and influenced by both non-genetic and genetic factors like season (which is related to availability of feed), semen quality and quantity and parity (Gebrekidan et al*.,* 2012).

Age at first calving

The age at first calving is the age when an in calf

individual give birth for the first time. First calving characterizes the start of the productive life of a cow having an influence on both reproductive and productive life of the female, directly having an effect on her lifetime calf crop and milk production, and indirectly through its influence on the cost that has been invested for the upbringing (Azage et al., 2011; Tewodros, 2008). In line with a study that was conducted recently, dietary supplementation of heifers during their growth period reported a decrease from birth to age at first service for the interval and age at first calving (Amin et al*.,* 2013).

Interval of calving

This is a period between two successive calving being the day's open and gestation length. Since the gestation length is less or more constant for a given breed, the number of days that is open becomes the sole variable of calving interval. Calving intervals do have low heritability and this can be enhanced through early breeding and nutrition (Mulugeta and Belayneh, 2013).

This is so important to the breeders because the lowest the calving interval will result into the highest lifetime for calf production. One of the major problems that affect the lifetime productivity of dairy herds is extended calving interval (Belay et al*.*, 2012a).

Year and season of calving, the genetic factors and nutrition and age of cow are all known to have significant effects on calving interval (Assemu, 2015). In an optimum combination of good management and sound physiological condition of the cow the reasonable short calving interval is 12-13 months. The average calving interval for Holestain Friesian/ zebu cross breed in and around Mekele was 401.5±73 days (Mekonnin et al., 2015).

The days that are open to breeding are clearly defined as the interval from calving down to the day of conception. This includes the period of postpartum anestrous interval and the service period. The days that are open are the most important that determine the component of calving interval which is highly influenced by the length of time for the uterus to completely involutes, accuracy of heat detection, resumption of normal ovarian cyclist, occurrence of silent ovulations, management decisions on how soon to rebreed following parturition, fertility of a bull or semen and efficiency and/or skill of inseminator. The average days that are open for dairy cattle to the time of conception were 155.7±1.72 days. Feed shortage, silent estrus and lack of proper heat detection are factors that have contributed considerably to the long days that are open in dairy cattle as described by Belay et al*.* (2012b).

Gestation Length (GL) is the period between the date of fertile service and the date of calving. This period is almost invariable within individual in a breed or type. Gestation length, which is more or less constant, varying slightly due to breed, calf sex, litter size, damage, year, and month of calving, and little can be done to significantly manipulate the gestation length (Asheber, 1992; Addisu and Hegde, 1999; Giday, 2001 and Fikrie et al*.,* 2007).

Lactation length and milk yield

The period through which a cow continues giving milk in one milking time is the length of lactation. The overall lactation length of indigenous cattle was 203.54 days (Asefa et al., 2015), 7.29 month (Kedija, 2007), 9.8 month (Adebabay, 2009), 9.13 month (Mulugeta and Belayneh, 2013) and 6 month (CSA, 2013). However, 305 days is the standard period for the normal length of lactation for cows that are calving at intervals of 12 months. In tropical cattle, restricting the lactation records to 305 days would have less effect, as few of the cows produce milk for more than 305 days. Lactation length can be affected by shortage of feed, poor management practices, difference in production system, age and breed of animal. The average milk yield of indigenous breeds of cattle per day was 1.25 liters (Asefa. et al., 2015), 4 liters (ILDP, 2004), 1.82 liters (Adebabay, 2009), 1.69 and 1.86 liter in first and second lactation respectively (Zewdu, 2004), 1.67 liters (Mulugeta and Belayneh, 2013) and 1.32 liters (CSA. 2013) which was also affected by different factors including management, climatic condition, disease problem, availability of water and feed, lactation cycle and parity of cows.

Breeding practice of dairy cattle

The pairing of female and male animals for the purpose of reproduction on a farm using artificial Insemination (AI) or natural methods is known as mating (Willam and Simianer, 2011). Similarly Godadaw et al*.* (2015) reported that the breeding practice of dairy cattle are mostly natural mating in which bulls can be used for either free mating (uncontrolled mating) in the range land or controlled mating and the use of AI in small scale were applied in dairy cattle breeding for production or reproduction purpose.

In the same vein, Gebremichael (2015) also reported that mating of dairy cattle in central zone of Tigray relied on natural mating (35%), AI without synchronization (42.77%) and AI with synchronization (22.22%), which was considered to be better in Ethiopia. Regarding technology transfer of breed improvement and trait preference of dairy cattle in that area was based on milk yield, fertility, body weight, feeding behavior, temperament, and color and disease resistance ability.

Operational breeding, efficient and systematic strategy are needed to bring about any considerable progress in the dairy sector. The development in dairy sector in Ethiopia in line with other developing countries can be expanded with the selection within the native cattle

besides crossbreeding (Zelalem et al*.,* 2011).

Furthermore, performance recording systems and formal pedigree are basically non-existent with the traditional husbandry in most of the tropical countries. Thus, under those conditions, the only option that is left to take is to select animals based on their phenotypic traits like body size, udder size etc. (Bebe et al., 2003). To get an effective breeding practice, it is expected for one to consider techniques and options that are good in improving the genetic performance of cattle.

Natural mating

In Ethiopia, the use of bulls for natural service remains widespread. Uncontrolled natural mating is the leading form of animal breeding system that is practiced under extensive husbandry in rural areas. This situation corroborates with studies by Mekonnen et al*.* (2012) and Azage et al*.* (2013), who described that natural mating prevails under extensive livestock husbandry system especially in the rural areas.

Similarly, Desta (2002) also specified that Ethiopian farmers prefer natural mating because the conception results from the AI services are always low. Zewdu (2004) also reported that most of farmers in Dembia and Fogera districts got their replacement (breeding) animals from their own farm and at times from their relatives and neighbors. It is that most of the farmers in rural lowland areas of Metema breed their cow with any bull that is made available in the village. This is as a result of most of the farmers not having their own breeding bulls and they make use of their neighbor's bulls or use open mating in the communal grazing land (Azage et al., 2013).

According to Godadaw et al. (2015), natural mating bulls can be used for either free mating in the range land or controlled mating .In free mating in the range land bulls can carry out heat detection and cows in heat are mated by bulls several times during each heat period and in controlled mating heat detection is carried out by the owner of the cows (farmer) and cows mate once or twice in each period. Also according to the report of Asrat et al*.* (2013), in Boditti Woreda under mixed crop-livestock production system most of the households rely on natural mating using native bulls while a small number of households depends on AI. The main source of breeding bulls for natural mating was own herd, village bull and neighboring bull in the range land of the community (Gebremichael, 2015).

Artificial insemination

This is a process in which sperm is collected from male animals and artificially introduced into the female reproductive tract for the purpose of fertilization (Webb, 2008). Sperm is stored and from one ejaculation of a bull about 200 to 300 portions of semen can be harvested (Niemann, 2006; Willam and Simianer 2011). Several potentials are offered by artificial insemination over natural service. The most common is the genetic improvement while others include safety breeding, cost effectiveness, disease control, flexibility, and fertility management (Ball and Peter, 2004; Geberemedhin, 2005; Holm et al*.,* 2008). Artificial insemination (AI) also plays a significant role in increasing the yield capacity of cows being the cheapest way of genetic improvement.

The availability of accurate heat breeding records like breeding dates, pregnancy rates, inter-estrus intervals and days to first service are used to monitor fertility (Sinishaw, 2005). Poor conception rates due to poor heat detection and inefficiency of AI technicians, dissemination of reproductive diseases and poor fertility rates if AI centers are not equipped with appropriate inputs and are not well managed (Desalegn, 2008). High cost of production (processing and collection), storage and transport of semen (Pope, 2000) were the major limitations of artificial insemination.

Breeding objective of dairy cattle

This is defined as the reasons for which animals are specifically bred for, having the notion that farmers have made a thoughtful choice to genetically improve the next generation of animals in terms of their performance in relation to their parent generation. The focus is therefore on one or more traits. The known objectives are likely to be affected by the cost of production and the revenue from product sales related to a genetic change in the target trait. Cattle are known to have multipurpose functions. These include income generation, milk production, manure, reproduction, traction, and meat production (Zewdu et al*.,* 2004).

The main breeding objective traits in dairy cattle were obtaining better milk yield (Godadaw et al., 2015 and Zewdu, 2004) and in addition increasing milk yield, obtaining of good breeding bull, and plough ox, good mothering ability and shortening of calving intervals were also aimed as breeding objective (Godadaw et al*.*, 2015) and the other traits important for obtaining breeding objectives were draught power, coat color, mothering ability, butter yield and getting marketable animals for better improvement and production.

Similarly cattle traits preference of the farmers in Dembia, Fogera and Wogera districts of Northern Amhara region of Ethiopia for achieving breeding objective was ranked sequentially as milk yield, adaptation, growth rate, draught power, breeding ability, cow coat color and better fat yield (Godadaw et al*.*, 2015).

Conclusion

Agriculture is the main economic activity in Ethiopia in

general and livestock is also the major among other agricultural activities. The largest livestock population in Africa is owned by Ethiopia. Livestock and dairy cattle contribute to agriculture, food and rural development of the country. Majority of the livestock population in Ethiopia are cattle which are reared across all the agro-ecologies. However, the productivity of cattle did not match their number due to prevalence of diseases, lack of breed improvement program, uncontrolled mating or breeding practice, shortage of feed, traditional production system and poor reproductive performance. By addressing these constraints to all stakeholders including the owners or farmers and designing appropriate mating or breeding systems is known to be one of the good options in improving breeding practice of dairy cattle in Ethiopia

Breeding practice needs to involve farmers, stake-holders in the sector, government policy, the existing breeding practices, production system, management systems and their trait preferences to upgrade the reproduction and production traits of dairy cattle. Exploring indigenous knowledge of managing the herd, setting of breeding objectives and finally designing appropriate mating systems with full participation of farmers is very important in improving dairy cattle production. Therefore, most of the livestock production system in Ethiopia is traditional based on low production potential of indigenous breeds of cattle. So, farmers should train different aspects of improving cattle productivity by considering the reproductive and productive traits for improvement of sustainable dairy cattle production and productivity.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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