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Review Article

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A review on causes of infertility and its averting mechanism in Crossbred dairy cows in Central Ethiopian

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Abstract

The aim of this paper was to review the major causes of infertility in Crossbred dairy cattle and its averting mechanism in central highland of Ethiopia. Crossbred dairy cows in different production systems in the country kept inpoor hygienic conditions, inadequate production space, poor record keeping for genetic progress and poor animal management. The research activities carried out on estrus synchronization and artificial inseminationat small scale dairy farmers' village has revealed a wide range of problems facing improved dairy cattle in the highland of the country. Seasonal variability of feed supply, lack of minerals supplementation, insufficientheat detection, lack of infrastructure for proper artificial insemination service, and lack of defined dairy breeding program are among the identified causes of infertility for the crossbred dairy cattle.To tackle infertility in crossbred dairy cows farmers should give attention on their high producing animalsand take action to minimize post-partum negative energy balance and post-partum infectious uterus, monitor estrus manifestation and optimize proper inseminations with quality semen.

Keywords: Environment, Estrus synchronization, Genetics, Management, Production systems

Introduction

Fertility in dairy cows has declined over the past five decades as milk production per cow has increased. Dairy production in Ethiopia which practiced in different production systems suffered from the infertility problems manifested in high producing cows. Many hypotheses have been proposed to explain this including issues of genetics, physiology, nutrition and management, and these factors have been investigated at the animal, organ and cellular level at critical time points of the productive life of dairy cows (Walsh *et al.*, 2011).Infertility is a term which includes all reasons for cows not conceiving after breeding. Infertility results in either culling of the cow or increased calving interval which reduces overall production efficiency.Fertility is a complex multi-factorial trait that includes the animal's genetic composition (Miglior, 1999) and environmental conditions such as nutrition and climate (Muller *et al.*,2014), the endocrine system (Potgieter, 2012),

the age of the animal and on-farm management practices. In enhancing fertility through advanced reproductive biotechnologies (ultrasound aided ovarian dynamics and luteal dynamics), a clear understanding of the hormonal mechanisms that control the estrus cycle is required to be known in different breeds for inseminators to detect estrus signs accurately to increase pregnancy rates. Repeat breeding or anestrus is the most common signs of infertility. Causes of repeat breeding may include bull infertility, improper semen handling, poor estrus detection, a nutritional imbalance, incorrect timing of insemination, or a decreased fertility level in the cow (Otterby*et al.,* 1983). Inadequate reproductive performance is one of the most costly problems facing dairy producers. Esslemont and Kossaibati (1997) found that poor fertility remained the single most important reason for involuntary culling, whatever the age of the animal. Milk yield and reproductive efficiency play major roles in determining the profitability of a dairy herd (Britt, 1985; Arbel*et al.,* 2001). Numerous studies have documented that additional days in which cows are not pregnant beyond the optimal time post calving are costly (Groenendaal*et al.,* 2004; Meadows*et al.,* 2005).

Ethiopia holds large potential for dairy development due to its large livestock populationand the favorable climate condition for improved, high yielding dairy cattle breed (Ahmed*et al.,* 2004). However, 97% of the dairy animals are low yielding local breed animals.So, integration of crossbred dairy cattle is imperative for dairy development in the country. However, improved dairy breeds require high management, technical support from both private and public sectors. AI service delivery and efficiency is poor due to lack of infrastructure to the dairy farmers' vicinity. Severe shortages,low quality and seasonal unavailability of feed also remain major constraints to livestock production in the country (Ahmed *et al.,* 2004).

Crossbreeding of local zebu cattle with improved exotic dairy breeds on a wide scale was introduced five decades back to upgrade milk production potential of the indigenous cattle, and subsequently to improve the dairy sector in country. Efforts have been made to improve the dairy sector through artificial insemination or shared crossbred bull service or by distributing crossbred F1 heifers particularly to the smallholder dairy farmers in urban and peri-urban areas and to those rural farmers located in close proximity to urban areas (Lobago*et al.,* 2006). However, reproductive and other animal performances depend not only on genetic merits, but also on other factors, such as nutrition, management, health, and environment.

The last seven years effort (by research centers and livestock development agents) to assist small scale dairy farmers crossbreeding program with AI and estrus synchronization, in the major milk producing district of the countrywas also hugely influenced by genotype, feed availability, true anestrus,heat detection problems,technological gap (lack of knowledge to AI and other reproductive technologies) and etc. Thus, dairy cattle crossbreeding programmes need to be monitored regularly, by evaluating the reproductive ability of the crossbred cattle under the prevailing management and environmental conditions.

The aim of this review paper is to shade light on the major causes of infertility and its averting mechanism in crossbred dairy cattle in the central highlands of Ethiopia.

Dairy cattle crossbreeding programs in Ethiopia

Crossbreeding of improved European dairy breed cattle with local zebu breeds was first introduced by Italians in the 1930's. In tropics the introduction of high-producing exotic breeds is hindered by prevailing heat stress, external and internal parasites, infectious disease, poor nutrition, and other concurrent problems (Lobago *et al.,* 2006). Wide-scale cattle crossbreeding activities were started later by the Institute of Agricultural Research (IAR) and Chilalo Agricultural Development Unit (CADU) using Holstein- Friesian, Jersey, and Simmental sires

that were crossed with the local Horro, Borana and Arsi dams (Brännäng *et al.,* 1980; EARO, 2001). Since then, governmental and non-governmental organizations have made various efforts to improve the dairy sector by establishing dairy cattle improvement ranches and distributing crossbred F1 heifers to smallholder farmers (EARO, 2001; Kelay, 2002).

Major factors affecting fertility in crossbred dairy cows

Various studies conducted to identify the major reproductive problems of crossbred dairy cows in the country. A study by Akinaw (2016) reported from the western Ethiopian part that, the prevalence of retained fetal membrane, dystocia, metritis, abortion, milk fever, pyometra, uterine and vaginal prolapseand repeat breedingas the major reproductive disorders in Horro Guduru Animal Breeding and Research Center. Other studies conducted at different locations and production systems such as Holleta, Addis Ababa, Assela, Mekelle, Debre Zeit, and Ada Berga also reported the above mentioned reproductive problems with different prevalence rate. Poor management and environmental conditions considered as possible causes of some reproductive problems (abortion) observed particularly in western Ethiopia (Akinaw, 2016). The overall causes of infertility in crossbred dairy cattle in the highland of the country can be summarized or attributed to genetics, physiology, nutrition, management and environment (Lobago *et al.,* 2006).

Genetics

Moges (2015) reported from north western Ethiopia (Gonder) that higher incidence of infertility problems encountered in crossbred cows (59.6%) than in indigenous zebu cows (52.6%). Crossbreds are more susceptible to disease and require elaborated management than indigenous zebu cattle (Takele *et al.,* 2005). There are indications that the genetic correlation between female fertility and milk production is antagonistic (Kadarmideen *et al.,* 2000; Royal *et al.,* 2002). Cows that have highly selected for milk production in recent decades have suffered a decline in fertility (Walsh *et al.,* 2011). It has long been known that fertility is reduced in lactating cows as compared to non-lactating heifers (Ron *et al.,* 1984; Nebel and McGilliard, 1993). Given that milk yield has increased over time as fertility has declined, the possibility must be considered that the increase in milk yield is one reason that has contributed to the decreased fertility in dairy cattle. On top of that, the associations of milk yield with reduced duration of estrus, increased days to first insemination, increased number of inseminations per conception, reduced first service conception rates, and reduced progesterone levels post-ovulation compromise herd fertility.

Advancements in genotyping by sequencing technologies have facilitated the identification of single nucleotide polymorphisms (SNPs), which provide additional data for use in genetic evaluations of animals (Kgari *et al.,* 2020). Genomic selection identifies genetically superior selection candidates based on breeding values predicted as the sum of allele substitution effects of thousands of genome-wide SNP markers from the reference populations with phenotypes and genotypes (Goddard, 2009). This allows early selection of young animals without phenotypic information, and reduces the generation interval, thus accelerating the rate of genetic improvement. High genetic gains can be achieved through using young animals without performance records as parents for the next generation (Buch *et al.,* 2012). However, the cost of genotyping is a limiting factor in the adoption of genomic selection in developing country such as ours.

Physiology

Shiferaw *et al.* (2005) reported the occurrence of most of the reproductive disorders in crossbred dairy cows in central highlands of Ethiopia as a complex rather than a single abnormality. Late age at sexual maturity and first calving, higher number of service per conception, and longer calving intervals are major areas of reproductive loss in cattle. Walsh *et al.* (2011) discussed the

physiological events such as negative energy balance, expression of oestrus,ovulation and fertilization, early increase in progesterone secretion from the corpus luteum (CL), uterine endometrium environment, and adequate quantities of interferon tau are physiological causes and consequences affecting fertility in dairy cows. The ovaries play the key roles in reproduction and any impairment in their functions can result in either sterility or infertility. The term fertility is applied to the cow denotes the desire and ability to mate, the capacity to conceive and to nourish the embryo and finally the power to expel a normal calf and fetal membrane. Most forms of functional infertility results in anoestrus that means a failure of cows to display estrus (Arthur *et al.*,1992). Detailed research has illustrated that some of the patho-physiological pathways explaining the association between the increase in milk production and decrease fertility. It has been reported that production levels go along with a deeper and more prolonged negative energy balance as can be measured by lowered levels of glucose, insulin growth factor-1 and insulin, and elevated levels of metabolites like ketone bodies and urea. As most of these metabolites are able to reach the ovaries and affect several cell types and hence negatively influence fertility (Sheldon, 2004).

The main estrous period behavioral sign of is standing to be mounted, which is used to determine the correct time to inseminate. However, this traditional way of detecting cows is unsatisfactory (Van Eerdenburg *et al.,* 1996). The percentage of cows that display standing to be mounted by other cows has decreased in high-yielding herds. A study by Roelofs *et al.* (2005b) showed thatonly 58% of cows were observed in standing estrus, leaving it more difficult to detect estrus. As a result, submission rate to AI would decrease and lead to reduced reproductive efficiency (Crowe *et al.,* 2018). However, the use of a combination of signs of estrus and heat detection aids has a positive association with reproductive efficiency (Rao *et al.,* 2013). Other methods of detection and quantifying estrus have been recommended, such as pedometers (Roelofs *et al.,* 2005a) and electronic activity tags (Lovendahl and Chagunda, 2010).Tail paint also has significant advantage to best detect animals in standing heat.

The reproductive efficiency of a dairy herd can be measured in several ways, such as by measuring pregnancy rate, percentage of cows calving each year, average calving interval, average number of days dry, and number of live calves born each year. Although each of these measures affects the profitability of the dairy business in a slightly different way, the calving interval affects both the total milk production of the dairy herd and the number of calves born. Moreover, Österman and Bertilsson (2003) suggested that by combining a longer calving interval with increased milking frequency, daily milk production from one calving to another could be increased, making an increased calving interval an interesting option for dairy farmers. In addition, an economic advantage in extending lactations (by 60 days) was found even in the case of high-yielding cows. Obese *et al.* (1999) reported from Ghana, that calving interval was significantly influenced by factors such as location, season of calving, parity, and BCS in smallholder dairy herds.

Nutrition

Lack of sustainable feed availability both in quantity and quality (in the country), Inadequate production space for crossbreeds, reproductive problem, and health problems were mentioned in all dairy production systems as the major reasons for culling of cows (Moges, 2015). Nutritional imbalances are just one cause of infertility in dairy cattle, however, often more than one nutrient may be involved or other non nutritional factors are partially to blame. These facts make it difficult to evaluate the effect of a single nutrient on infertility (Moellers and Riese, 1988). More recent research indicates slight deficiencies or imbalances of either major or minor nutrients may decrease fertility in apparently normal, cycling dairy cows. Animals gaining weight had a higher conception rate than those losing weight (Weaver, 1987). For optimum fertility heifers should be

gaining weight for 30 days before and after breeding (Ward and Marion, 1971)

Management

Management factors such as accuracy of heat detection, use of proper inseminating techniques, proper semen handling, and appropriate herd health policies can directly influence the reproductive performance of a dairy herd (Lobago *et al.,* 2006). In addition other factors beyond the immediate control of management may impact fertility; these factors include milk production of the cow, age of the cow, and season of year (Hillers *et al.,* 1984). The calving-to-conception interval is influenced by cow and management/environment related factors, such as method and efficiency of heat detection, type and efficiency of breeding service and the ability of the cow to resume regular ovarian cyclicity after calving, display an overt heat signs, and conceive with the given service. An appropriate reproductive health management, a reliable artificial insemination service and supplementary feeding suggested as management option to reduce reproductive problems (Shiferaw *et al.,* 2005). The key to optimizing the resumption of ovulation in dairy cows is appropriate pre-calving nutrition and management so that the cows calve down in optimal body condition (BCS of 2.75 to 3.0) with postpartum body condition loss restricted to 0.5 BCS units (Crowe *et al.,* 2014). This would ensure that cows would become inseminated shortly after calving and conceive earlier, resulting in shorter calving intervals. To tackle infertility in crossbred dairy cows farmers should give attention for high producing animals and take action to minimize post-partum negative energy balance and post-partum infectious uterus, monitor estrus manifestation and proper insemination with quality semen.

Environment

In Ethiopia, even though dairy cattle are maintained under different production systems (ILCA, 1994; Shiferaw *et al.*,2003), the differences in management or production systems and environmental conditions under which cattle are kept could greatly affect incidence of reproductive disorders. Reproduction in dairy cattle is highly affected by environmental factors and when environmental conditions are favorable, reproductive activity expresses its full potential. Favorable conditions must include adequate photoperiod, thermo neutral conditions, feed availability in quantity and quality, and a low stress environment. Inadequate conditions may lead to a decrease in reproductive capacity, varying from sub-fertility to infertility.

Therefore, the expression of the reproductive potential is only possible when animals develop and establish a homeostatic equilibrium with their external environment (V̇ctor *et al.,* 2015). Avariety of environmental factors affect the onset of ovarian cycles in the postpartum period and the most important of these are suckling, milk yield, nutritional status, and season (Peters, 1984). Swensson *et al.* (1981) suggested that malnutrition, disease, milk let-down interference, weak heat symptoms, and inbreeding are factors that commonly result in very low fertility in unimproved breeds.

Functional infertility

Abraham (2017) recently reviewed the functional causes of infertility that tend to affect individual animals within a herd but they constitute an important cause of infertility; furthermore when they affect a large number of a particular sub group in a herd they frequently reflect on the causes of infertility such as nutrition. Most functional aberrations occur because of some endocrinological abnormality which is frequently difficult to specify even with current methods of hormone assay, particularly when single, spot samples of blood or milk are examined. The abnormalities occur as a result of inherited factors; nutritional deficiencies or excess social influence which may arise from modern husbandry methods, for instance the grouping of large numbers of cows thus interfering with the establishment of a stable

social hierarchy; and the stress of production (Arthur *et al.*, 1992).

Abraham (2017) reviewed some of the common causes of functional infertility in dairy cows such as non detected estrus (silent estrus), anoestrus, ovulatory defects, persistent corpus luteume, cystic ovaries, luteal deficiency and repeat breeding problems.

Conclusion and Recommendation

Research and development activities carried out on estrus synchronization and AI has revealed a wide range of problems facing improved dairy cattle in the highland of the country. Crossbred dairy cows in different production systems in the country kept in poor hygienic condition, inadequate production space, poor record keeping for genetic progress and poor management. Seasonal variability of feed supply, lack of minerals supplementation, insufficient heat detection, lack of infrastructure for proper AI service, and lack of defined dairy breeding program are among the identified causes of infertility for the crossbred dairy cattle. To improve the Crossbred dairy cattle fertility, future strategies and breeding programs should focus on the environmental factors affecting fertility and boosting the genetic potential of elite animals in the production systems.

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