

REVIEW ARTICLE

DIFFERENT PERSPECTIVES OF SELECTIVE BREEDING IN COW: A REVIEW

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ABSTRACT

Selective breeding in cows has been practiced in the past for different desirable traits in animals. In recent decades, it has led to a tremendous increase in milk yield. Along with its increase in yielding capacity, it has become one of the prominent factors leading to different diseases, disorders, declining longevity, mastitis problems, increased lameness, and other metabolic effects. On the one hand, selective breeding has been an effective management tool in maintaining diversity in breeds while on the other hand because of several associated effects, has caused many problems. This review thus focuses on the diverse perspectives of selective breeding in cows. This paper aims to address and improve the selection scenarios in various programs. Different journals were searched and studied on related topics before starting the review. The journals were selected from different parts of the world randomly visualizing the overall conditions of cows while doing selective breeding. Generally, people focus on the yielding capacity of cows neglecting other health traits, and the fertility state has been inviting a bigger problem. But now, in many countries, only the yield factor is not considered but rather includes fertility, conformation, efficiency, and health of cows along with the incorporation of many developed technologies. According to the preference of the breed, important differences can be found in farming systems in breeding goals and various breeding scenarios. If it is to consider the breeding programs without leading to the extinction of local breeds then sure there is a chance that breeds can be well preserved effectively but the technologies used must maintain the naturalness of breeding and the breed must fit the existing farming system.

KEYWORDS

Breed diversity, cattle breeding, genetic variation, traits.

1. INTRODUCTION

Approximately 18% of the global cattle population is from South Asian and Pacific (SAP) countries. Smallholders provide around 90% of the livestock in Asia, and this percentage is very stable between nations. The majority of SAP nations use similar procedures for formulating policies and carrying out projects to enhance the genetics of dairy and beef cattle, but the degree of engagement varies depending on socioeconomic considerations. Several efforts have been made to improve the milk-yielding capacity of cattle through selective breeding. A study done reveals that animals managed in good conditions and bred from native foundation stock led to a faster growth rate, a high butterfat content, and good body complexity by (Anderson, 1935). Dairy farmers should choose replacements with pedigrees for high output and bulls with high anticipated difference milk to generate genetically better progeny since they are compensated for the milk they gather (Shanks et al., 1978). If we look at the African continent, it is being increasingly recognized that Africa possesses animal genetic resources probably unparalleled on any other continent. By using selective breeding, these resources have started to offer ecologically friendly, long-term answers to the numerous disease issues that now plague Africa (Murray et al., 1990).

More recently, the selection of individuals for breeding programs can be based on either phenotypic or genotypic merit. Selection techniques have evolved throughout time to become more scientific. Breeders of dairy cattle currently prioritize qualities including production, conformation, lifespan, fertility, and health in many different nations (VanRaden, 2004). The existence of breeds other than Holstein and the growth of sables

within the Holstein help sustain genetic diversity (Brotherstone and Goddard, 2005). A sizeable portion of other breeds' likely chosen locations is shared by Russian cattle breeds. Different positive or negative consequences are seen on an animal's features as a result of the selection pressure we applied, either favorably or adversely (Zhao et al., 2015). If a better strain is created, there is a high likelihood that it will disappear quickly through dispersion (if not outcrossing) (Donald and el Itkiby, 1946). Although milk output was successfully enhanced by choosing replacement heifers based on predicted breeding values, health problems, and medical expenses also rose. When compared to low-pedigree cows, high-pedigree cows did make \$45.80 more each lactation. (Shanks et al., 1978). Numerous behavioral, physiological, immunological, and reproductive features as well as animal welfare have been considered as being in danger due to today's selection for high production efficiency in livestock animals (Rauw et al., 1998). Future problems for livestock breeding include the need for rapid genetic advancement for both new and current qualities, such as feed conversion efficiency, fertility, and climatic tolerance. It is crucial to emphasize animal health and welfare, even as the nutritional value of meat and milk is improved (Hayes et al., 2013). Increasing the number of daughters per test bull can increase functional attributes in cattle (Harder et al., 2004).

This review article was created following a thorough analysis of all the data gathered from all the relevant sources. In this paper, instances of both positive and negative consequences of cow selection are discussed from several angles. The repercussions of selection are examined along with a potential explanation.

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2. DIVERSITY IN BREEDS

Artificial selection frequently favors certain features, creating rapid evolutionary changes in animals that are perpetuated via heterozygote advantage (Hedrick, 2015). Additionally, it is distinguished by the variety of cattle (Gutiérrez-Gil et al., 2015). Different findings made discovered that the sires with higher milk yields were more effective than the unselected ones by (Barnes et al., 1985). Breeding initiatives have a track record of producing mixed populations of superior cattle, crossbred animals, and purebred animals). Better genetic gain rates in dairy cattle breeding operations may result from genetic assessment utilizing genomic data, which would also help to reduce the population's average inbreeding coefficient (De Oliveira Seno et al., 2018).

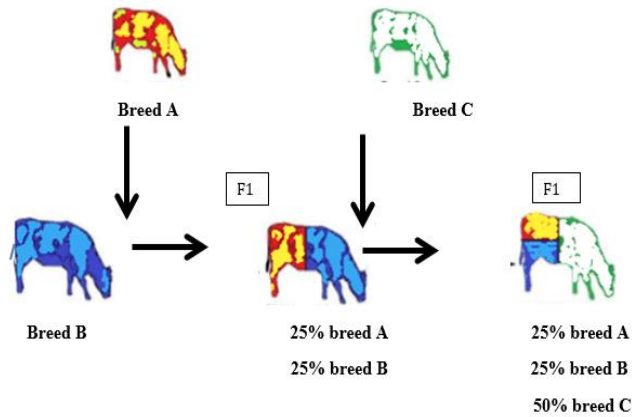


Figure 1: Representation of a three-breed cross.

Table 1: Showing different breed categories along with examples	
Breed category	examples
1. Non- improved breed	Nepal- Siri, Lulu, Achhami, Terai cattle India- Red Sindhi, Sahiwal, Indian Zebu Bangladesh-Indigenous zebu, Hariana SriLanka- Indigenous Zebu, white Cattle, Cape Myanmar-Shwe Ni, Shwe-ni-gwi
2. Selectively breed since the 18 th or 19 th century with limited influence of imported sires	Jersey Hallikar Hereford BCB-1 Ongole
3. local crossbreds	N'Dama Grande Austrain Yellow Fellata Swona Tarai Pabna
4. Modern breed (developed by crossing local females to sires of international breeds)	Fleckvish Brown Mountain Several Black-Pied Friesian
5. Composite breed	Viking Red Girolando Heck cattle

Sources: (Deb et al., 1970; Felius et al., 2015)

2.1 Diversification Based Farming

Local breeds can be used to produce different productive breeds because of their good adaptive characteristics (Yurchenko et al., 2018). According to the importance assigned in the various farming methods, different breeds are chosen. In the table, several of them are listed.

Different farming-based system	Priority given	Examples in the order of distribution of breeds
Multifunctional dairy farming	The more importance was focused on natural breeding and preference for breed	Dutch breeds, Holstein Friesian cross breed, foreign breeds (Brown Swiss, Swedish Red), Holstein Friesian, others, and Jersey
Specialized dairy farming	More concentrated on milk yield, milk components, and high age per cow	Holstein Friesian cross breed, Holstein Friesian, Dutch breeds, foreign breeds, Others, and Jersey
Low input farming	Focusing on natural services and important aspects includes udder health, ease of birth, functional character	Dutch breeds, Holstein Friesian cross, foreign breeds, Holstein Friesian, Others, and Jersey
High input farming	More focused on milk yield, milk per lactation	Holstein Friesian cross, Holstein Friesian, Dutch breeds, foreign breeds, Others

Source: (Yurchenko et al., 2018)

2.1.1 Correlation to milk production

Artificial selection enhances milk production by boosting the frequency of alleles that impact milk production features (Hayes et al., 2009). In contrast to a dairy cow not exposed to selected breeding, selective breeding allows a dairy cow to produce enough milk for 10 calves (Chapin and Chapin, 2019). However in their findings said that, choosing daughters of high milk yielding sires resulted in lifetime profits that were 18% higher than those of daughters of ordinary milk yielding sires (Bertrand et al., 1985). Higher expenditures for health and feed are offset by an increase in the average milk production revenue (Bertrand et al., 1985; Dunklee et al., 1994a). While selecting high pedigree cows, research findings stated, they did, in fact, earn \$45.80 more each lactation than low pedigree cows by (Shanks et al., 1978).

2.1.2 Economic Merit

Larger breeds have a better chance to respond to selection than small breeds since their market potential is more highly valued (Biscarini et al., 2015). Due to the existence of trypanotolerance in local populations and selective breeding efforts, the problem of trypanosomiasis in cattle on the African continent was reported to have caused less significant losses on several production bases (Murray et al., 1990). The selection of specialized breeds for diverse features is more profitable than for numerous traits of a single breed if the goal is to increase profits (VanRaden, 2004).

2.1.3 Health Of Cattle

Disease trait appears to be more of an economic feature in any breeding program than many other qualities since it comes with numerous complications for cattle. The selection of high milk-producing cows brings several issues with fitness and health too (Williams, 2005). Cows who are breastfeeding in hot climates experience heat stress, and selection for heat tolerance without taking into account productivity may have an impact on an animal's behavior or performance (West, 2003).

An apparent low heritability of a disease characteristic in cattle allows for selection of individual animal presentations to enhance several genetic enhancements (Shook, 1989). Belgian blue calves were chosen for double muscling, which eventually brought to surgical issues and other wound issues. The lifetime of dairy cattle has reduced in the past due to a greater emphasis on output based on selective breeding (Pickett, 2008).

2.1.4 Mastitis

The incidence of clinical mastitis per cow per year varies between 20 and 40% (Heringstad et al., 2000). A high level of mastitis in the UK dairy herd was seen whereby selective breeding for enhanced milk yield is the root cause along with causing a decline in longevity (Pickett, 2008; Kossabati et al., 1998). Mastitis resulted in a number of production-related issues,

rising treatment costs, and decreased milk quality (Dunklee et al., 1994b; Heringstad et al., 2000; 2001).

3. REPRODUCTION

One of the most crucial features in any breeding program has always been reproduction, which has a significant impact on generating results (Goyache, 2001). Essl (1998) suggested that the c. Generally, the stress given to cattle during breeding programs is negatively related to the fertility/ reproductive stage of the dairy cow (Hansen et al., 1983). The suggested that disturbed reproduction is due to decreased expression of visual estrus in association with ovulation (Harrison et al., 1990). Selective breeding of cows in some breeds has triggered to this lowered rate of fertility (Williamson, 2014).

3.1 Loss Of Variation Between And Within Breeds

A high level of selective breeding leads to decreased genetic variation in livestock (Giovambattista et al., 2001; Gutiérrez-Gil et al., 2015). If the practice of breeding programs excludes importing animals from other climates and situations, local races of breeds will develop distinctive genetic makeups in contrast to others (Lush, 1960).

Due to shared breeding goals and international cattle trade, there generally seems to be a selection of comparable animals. Due to these factors, Holstein makes up a large section of the population in developed nations. Some genetic variety in dairy cattle has been lost, mostly as a result of the development of restricted breed programs (Brotherstone and Goddard, 2005). Numerous indigenous breeds were also overlooked as breeding programs improved.

3.2 Limitations In Selective Breeding

Numerous agricultural animals are subjected to significant physiological stress, discomfort, and damage as a result of selective breeding. Cows' milk production is always rising, making it more challenging for them to mobilize a lot of body fat quickly (Gallo et al., 1996). This could end up being a significant limiting factor for dairy cows chosen for high producing. When compared to other production variables, functional traits have a lower heritability (Boettcher, 2016). Mastitis is seldom prevented because of the disease's poor heredity, despite the possibility that it might enhance some features. Numerous times, various aspects, including education level, less breeding bulls, cattle diseases and disorders, and less market structure influences, enhance the output of beef cattle (Mapiye et al., 2018). The rate of homozygosity undoubtedly rose as a result of enhanced artificial selection of cow breeds (Kim et al., 2013; Kim et al., 2018). This results in increased chances of mutations, susceptibility to diseases, and other associated problems. Developing organic animal breeding invites some institutional and practical difficulties to tackle along with breeding strategies (Nauta et al., 2005).

4. RECENT ADVANCES

In the industrialized world, technological advancements like artificial insemination (AI) and embryo transfer have been used to increase selection for genetic gain in some species (Williams, 2005). As a result, the degree of production from the selective improvement of cattle has dramatically increased in nations where the economic context supports high input agriculture. Numerous genital and non-genital illnesses have decreased as a result of selective breeding techniques like AI, which are mostly employed to enhance cattle. A study suggested sire selection, together with the cattle's genetic characteristics and economic worth, is crucial to AI performance by (König et al., 2007). recommended that three potential new phenotypes (same-day hemolytic analysis, same-day measures of skin hypersensitivity reactions, and artificial infestations using the "tick bag") be developed and further investigated to determine the practical feasibility of cost-effective, reliable cattle tick resistance in thousands of individuals in commercial and smallholder farmer herds in tropical and subtropical areas worldwide (Burrow et al., 2019).

To enhance traits such as reproductive rate, body composition, growth rate, and meat quality in pigs, sheep, and cattle, marker-assisted selection has been employed in several livestock species. (Dekkers, 2004). This has created the potential to increase selection response, particularly for qualities that are challenging to improve by traditional selection. A research paper estimated that the appropriate breeding objective of selective breeding and their mitigation tactics might lower the CH4 intensity by 24% in 2050 by (de Haas et al., 2021).

5. CONCLUSION

From the above review, it is well justified that selective breeding in a cow is associated with both positive and negative effects with some limitations.

Numerous undervalued breeds of cows may be on the verge of extinction if cow breeds are chosen primarily on economic viability. Consequently, various systems are required for tiny breed selection. To create more robust cows with better health, welfare, fertility, and lifespan, new breeding objectives are required. It is necessary to create performance logs that include both the evaluation of the ancestor and collateral relatives as well as the recording of the performance of the cattle as of the current date. By observing pertinent features, it also assists in monitoring phenotype. For the selection process to be more accurate, it is necessary to take into account a variety of elements, including knowledge of the connection (both phenotypic and genotypic) between features, as well as their heritability and economic relevance.

Numerous technological advancements in the breeding industry have emerged due to the rising need for cows who are high-yielding, have good body conformation, and are less susceptible to illnesses. For the scientific characterization of cattle genetic resources, breed groups and scientists must effectively engage in this respect. Additionally, in order to satisfy public demand, it is essential to concentrate on prospective issues by using modern technology for the selection of genetically better animals with contemplative bearing. It is imperative to outlaw breeding methods that are stressful and painful for the animals involved, maintaining their healthy wellbeing through better management procedures.

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