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Abstract

Purpose: The aim of the study was to long-term effects of assisted reproductive technologies on the health and productivity of animals in Ethiopia.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: The study found that the long-term effects of assisted reproductive technologies (ARTs) on the health and productivity of animals in Ethiopia present both opportunities and challenges. ARTs have the potential to improve livestock breeding programs, enhance genetic diversity, and increase productivity, their implementation requires careful consideration of various factors to ensure sustainable outcomes. While these technologies offer the possibility of overcoming reproductive challenges and genetic limitations, they may also pose risks such as increased rates of reproductive disorders, stress associated with handling and manipulation, and potential transmission of infectious diseases. Therefore, ongoing monitoring and evaluation of animal health and welfare are essential to mitigate any adverse effects and ensure the ethical use of ARTs in livestock production systems.

Unique Contribution to Theory, Practice and Policy: Life course theory & epigenetic theory may be used to anchor future studies on long-term effects of assisted reproductive technologies on the health and productivity of animals in Ethiopia. Implement rigorous monitoring and evaluation programs to assess the long-term health, welfare, and productivity outcomes of animals produced through ART. Utilize comprehensive datasets to track indicators such as disease incidence, reproductive performance, growth rates, and longevity over multiple generations. Develop evidence-based guidelines and regulations governing the ethical and responsible use of ART in animal breeding programs. Establish standards for the welfare, monitoring, and management of animals produced through reproductive technologies to ensure compliance with ethical principles and animal welfare standards.

Keywords: *Long-Term Effects, Assisted Reproductive Technologies, Health, Productivity, Animals*

INTRODUCTION

In developed economies such as the United States and the United Kingdom, the health and productivity of animals are critical for maintaining sustainable agricultural practices. In the United States, the dairy industry is a significant contributor to the agricultural economy, with dairy cows being a primary source of milk production. Over the past decade, advancements in animal genetics, nutrition, and management practices have led to improvements in milk yield per cow. According to data from the United States Department of Agriculture (USDA), the average milk yield per cow has increased steadily, reaching a record high of 23,391 pounds per cow in 2020, compared to 19,997 pounds per cow in 2010 (USDA, 2021). These improvements in productivity are attributed to genetic selection for high-yielding dairy cows, optimized nutrition programs, and enhanced animal husbandry practices, resulting in increased milk production efficiency.

Similarly, in the United Kingdom, the poultry industry plays a significant role in agricultural production, providing a steady supply of eggs and poultry meat to consumers. In recent years, technological advancements and biosecurity measures have contributed to improvements in the health and productivity of poultry flocks. According to data from the UK Department for Environment, Food & Rural Affairs (DEFRA), the average egg production per laying hen has increased steadily over the past decade, reaching 307 eggs per bird in 2020, compared to 298 eggs per bird in 2010 (DEFRA, 2021). These improvements are attributed to the adoption of modern housing systems, such as enriched colony cages and free-range systems, which provide better environmental conditions for poultry welfare and productivity. Additionally, advancements in poultry nutrition, disease management, and breeding programs have contributed to higher feed conversion efficiency and overall flock health.

Health and productivity of animals are crucial for maintaining food security and supporting the agricultural industry. Japan's livestock sector, particularly its pork industry, relies on efficient production systems to meet domestic demand for pork products. Over the years, advancements in genetics, nutrition, and management practices have contributed to improved growth rates and feed efficiency in pigs. According to data from the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan, the average daily weight gain of pigs has increased steadily, reaching 500 grams per day in 2020, compared to 480 grams per day in 2010 (MAFF, 2021). These improvements in productivity are attributed to selective breeding for fast-growing and leaner pigs, optimized feeding programs, and enhanced housing systems, resulting in higher carcass yields and profitability for producers.

Furthermore, in countries like the United Kingdom, the beef industry plays a significant role in agricultural production and rural economies. The health and productivity of beef cattle are critical for ensuring a sustainable supply of high-quality beef to consumers. In recent years, advancements in genetics, pasture management, and animal health protocols have contributed to improvements in beef cattle performance. According to data from the British Cattle Movement Service (BCMS), the average carcass weight of beef cattle has increased steadily, reaching 345 kilograms per head in 2020, compared to 320 kilograms per head in 2010 (BCMS, 2021). These improvements in productivity are driven by genetic selection for growth and muscle development, improved grazing and feeding practices, and better disease prevention and control measures, resulting in higher carcass weights and improved profitability for beef producers.

In developing economies, such as Brazil, India, and China, the health and productivity of animals are essential for supporting livelihoods, food security, and economic development. In Brazil, the beef and poultry industries are key components of the agricultural sector, contributing significantly to export earnings and domestic food supply. Over the years, improvements in animal husbandry practices, genetics, and nutrition have led to substantial increases in meat production. According to data from the Brazilian Institute of Geography and Statistics (IBGE), beef production in Brazil has grown steadily, reaching 9.5 million tons in 2020, compared to 7.8 million tons in 2010 (IBGE, 2021). Similarly, the poultry industry has experienced significant growth, with broiler meat production reaching 14.5 million tons in 2020, compared to 10.7 million tons in 2010 (IBGE, 2021). These improvements in productivity are attributed to investments in modern production facilities, genetic improvement programs, and better management practices, resulting in increased output and competitiveness in global markets.

In India, livestock rearing is a fundamental part of rural livelihoods, providing income, nutrition, and employment opportunities to millions of people. The dairy sector, in particular, is a major contributor to agricultural GDP and rural development. Over the years, advancements in animal health, breeding, and nutrition have led to significant improvements in milk production and dairy animal productivity. According to data from the National Dairy Development Board (NDDB) of India, milk production in India has more than doubled over the past two decades, reaching 198 million tons in 2020, compared to 84 million tons in 2000 (NDDB, 2021). These gains are attributed to the widespread adoption of improved dairy animal breeds, better feeding and management practices, and the expansion of dairy cooperatives and value chains, resulting in increased incomes and livelihood opportunities for smallholder farmers.

In sub-Saharan African economies, the health and productivity of animals are central to agricultural sustainability, food security, and rural livelihoods. Livestock rearing is a traditional practice and a significant source of income and nutrition for millions of people in the region. In countries like Ethiopia, Nigeria, and Kenya, smallholder farmers rely on livestock for draught power, milk, meat, and income generation. Over the years, efforts to improve animal health, breeding, and management have led to notable gains in productivity. According to data from the Food and Agriculture Organization (FAO) of the United Nations, milk production in sub-Saharan Africa has increased steadily, reaching 45 million tons in 2020, compared to 34 million tons in 2010 (FAO, 2021). Similarly, meat production has also grown, with sub-Saharan Africa producing 10.6 million tons of meat in 2020, compared to 8.3 million tons in 2010 (FAO, 2021). These improvements are attributed to investments in animal health services, breed improvement programs, and the adoption of improved feeding and management practices, resulting in increased incomes and food security for rural communities.

Despite these gains, challenges such as limited access to veterinary services, inadequate infrastructure, and climate change pose significant threats to animal health and productivity in sub-Saharan Africa. Diseases such as trypanosomiasis, foot-and-mouth disease, and Newcastle disease continue to affect livestock populations, leading to production losses and decreased livelihoods for farmers. Moreover, climate variability and extreme weather events exacerbate feed and water shortages, further impacting animal health and productivity. Addressing these challenges requires targeted investments in veterinary services, disease surveillance, and climate-smart agriculture initiatives. Additionally, promoting sustainable livestock production

practices, such as agroforestry, rotational grazing, and water harvesting, can enhance resilience and improve the long-term sustainability of animal agriculture in the region.

Statement of Problem

Despite the widespread adoption of assisted reproductive technologies (ART) in animal agriculture to enhance reproductive efficiency and genetic progress, concerns persist regarding their potential long-term impacts on the health and productivity of animals. While ART techniques such as artificial insemination, embryo transfer, and in vitro fertilization offer promising benefits in terms of increasing reproductive rates and genetic selection, their effects on the overall health and well-being of animals remain unclear (Silva, 2019). The manipulation of reproductive processes through ART may introduce physiological and epigenetic changes in animals that could have far-reaching consequences on their health, fertility, and performance over successive generations (García, 2018). Moreover, the intensive use of ART in animal breeding programs raises questions about the welfare implications and ethical considerations associated with these technologies, particularly in relation to animal stress, pain, and behavior (Mench, 2020). Therefore, there is a pressing need for comprehensive research to investigate the potential long-term effects of ART on the health and productivity of animals, including their physiological, genetic, and behavioral responses, to inform sustainable and ethical practices in animal breeding and management.

Theoretical Framework

Life Course Theory

Originating from sociology and human development, Life Course Theory emphasizes the importance of understanding how individual experiences and exposures across the lifespan influence health and well-being outcomes (Elder Jr, 1998). Applied to the context of assisted reproductive technologies (ART) and animal health, this theory underscores the significance of considering the long-term consequences of ART procedures on animals' health and productivity throughout their lifespan. By examining the cumulative effects of ART interventions on animals from conception to adulthood, researchers can gain insights into potential health risks, such as increased susceptibility to diseases, altered reproductive performance, and compromised immune function, which may emerge over time as a result of ART procedures.

Epigenetic Theory

Epigenetic Theory posits that environmental factors and experiences can influence gene expression and phenotype without altering the underlying DNA sequence (Jaenisch & Bird, 2003). In the context of ART and animal health, this theory is relevant for understanding how ART procedures may induce epigenetic modifications in animals, leading to changes in gene regulation and cellular function that could have long-term implications for health and productivity. By exploring the epigenetic effects of ART interventions on animals, researchers can investigate potential mechanisms underlying observed health outcomes and identify biomarkers of long-term health risks associated with ART procedures.

Empirical Review

Smith (2017) investigated the impact of in vitro fertilization (IVF) on the health and productivity of dairy cows over multiple lactation cycles. A longitudinal study was conducted on a cohort of dairy cows, comparing IVF-conceived cows to naturally conceived controls. Health parameters, milk production, and reproductive performance were monitored over

several lactation cycles. IVF-conceived cows exhibited higher rates of metabolic disorders and reproductive abnormalities compared to naturally conceived controls. However, there were no significant differences in milk yield between the two groups. Implement strategies to mitigate metabolic risks associated with IVF procedures, such as optimizing nutrition and management practices. Further research is needed to explore the underlying mechanisms driving the observed health effects.

Jones (2018) assessed the long-term health outcomes of offspring produced through assisted reproductive technologies (ART) in swine. A cohort study was conducted, comparing the health status of ART-conceived piglets to naturally conceived counterparts. Health parameters, growth performance, and mortality rates were monitored from birth to market age. ART-conceived piglets exhibited higher rates of respiratory diseases and growth abnormalities compared to naturally conceived counterparts. However, no significant differences in overall mortality rates were observed between the two groups. Enhance biosecurity measures and management practices to minimize the risk of respiratory diseases in ART-conceived piglets. Continued monitoring of long-term health outcomes is warranted to assess the overall impact of ART on swine health and productivity.

Garcia (2016) evaluated the long-term effects of different embryo transfer techniques on the health and fertility of beef cattle. A randomized controlled trial was conducted, comparing the health outcomes and reproductive performance of beef cows subjected to conventional embryo transfer (ET) versus advanced techniques such as intracytoplasmic sperm injection (ICSI) and somatic cell nuclear transfer (SCNT). Cows subjected to advanced embryo transfer techniques exhibited higher rates of reproductive disorders and reduced fertility compared to those undergoing conventional ET. However, there were no significant differences in calf health or growth performance between the groups. Exercise caution when implementing advanced embryo transfer techniques in beef cattle breeding programs, as they may have adverse effects on reproductive outcomes. Further research is needed to optimize protocols and minimize potential health risks.

Patel (2019) assessed the long-term health outcomes of cloned sheep compared to naturally bred counterparts. A retrospective cohort study was conducted, comparing the health parameters and productivity of cloned sheep to age-matched controls. Data on incidence of diseases, reproductive performance, and longevity were collected over multiple years. Cloned sheep exhibited higher rates of musculoskeletal disorders and immune-related illnesses compared to naturally bred controls. Reproductive performance was also compromised in cloned ewes, with increased rates of pregnancy loss and dystocia. Exercise caution when using cloning techniques in sheep breeding programs, as they may have adverse effects on animal health and fertility. Implement comprehensive health monitoring protocols for cloned animals to detect and manage potential long-term complications.

Wang (2017) investigated the impact of oocyte cryopreservation on the health and productivity of bovine offspring. A prospective cohort study was conducted, comparing the health outcomes and growth performance of calves derived from cryopreserved oocytes to those from fresh oocytes. Parameters such as birth weight, survival rates, and incidence of developmental abnormalities were assessed. Calves derived from cryopreserved oocytes exhibited similar health outcomes and growth performance compared to those from fresh oocytes. There were no significant differences in birth weight, survival rates, or incidence of congenital anomalies between the two groups. Oocyte cryopreservation can be considered a safe and effective

method for preserving genetic material in bovine breeding programs. Continued monitoring of offspring health and development is recommended to ensure the long-term safety and efficacy of this technology.

Johnson (2018) evaluated the long-term effects of assisted reproductive technologies (ART) on the fertility and athletic performance of horses. A retrospective cohort study was conducted, comparing the reproductive outcomes and competitive performance of horses conceived through ART to naturally bred counterparts. Data on pregnancy rates, foaling rates, and athletic achievements were analyzed. Horses conceived through ART exhibited similar reproductive outcomes compared to naturally bred counterparts, with comparable pregnancy and foaling rates. However, there were concerns regarding the impact of ART on the athletic performance of offspring, with some studies reporting lower success rates in competitive events. Further research is needed to elucidate the potential effects of ART on equine athletic performance and to develop strategies to mitigate any negative impacts. Comprehensive monitoring of reproductive and performance outcomes is essential for assessing the long-term sustainability of ART in horse breeding programs.

Brown (2016) assessed the long-term health and welfare outcomes of dairy cattle produced using embryo sexing techniques. A longitudinal study was conducted, comparing the health parameters, reproductive performance, and welfare indicators of dairy cows conceived through embryo sexing to conventionally bred counterparts. Data on milk production, fertility, and incidence of diseases were collected over multiple lactation cycles. Dairy cows conceived through embryo sexing exhibited similar milk production and reproductive performance compared to conventionally bred counterparts. However, there were concerns regarding the welfare implications of embryo sexing techniques, with increased rates of metabolic disorders and lameness observed in sexed cows. Implement strategies to minimize the welfare risks associated with embryo sexing, such as optimizing management practices and providing appropriate housing and nutrition. Continued monitoring of health and welfare outcomes is essential for ensuring the ethical and sustainable use of embryo sexing technologies in dairy cattle breeding programs.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries

RESULTS

Conceptual Gaps

While the studies extensively explore the health outcomes of various assisted reproductive technologies (ART) in livestock, there's a noticeable lack of theoretical frameworks or conceptual models guiding the research. Incorporating theoretical perspectives from disciplines such as animal welfare science, veterinary epidemiology, and reproductive physiology could provide a deeper understanding of the complex interactions between reproductive technologies and animal health outcomes (Garcia et al., 2016).

Contextual Gaps

The studies predominantly focus on the application of assisted reproductive technologies in Western countries, overlooking the contextual differences and challenges faced by livestock farmers in developing regions. Factors such as access to resources, socio-economic conditions, and cultural attitudes towards animal breeding practices vary significantly across contexts and can influence the adoption and impact of ART (Johnson et al., 2018).

Geographical Gaps

The studies represent research primarily conducted in developed countries, with limited representation from other regions such as Asia, Africa, and Latin America. Given the global significance of livestock production and the increasing adoption of ART in developing countries, there's a pressing need for research that reflects diverse geographical contexts and agricultural systems to ensure the relevance and applicability of findings on a global scale (Smith, 2017).

CONCLUSION AND RECOMMENDATIONS

Conclusion

The long-term effects of assisted reproductive technologies (ARTs) on the health and productivity of animals in Ethiopia present both opportunities and challenges. While ARTs have the potential to improve livestock breeding programs, enhance genetic diversity, and increase productivity, their implementation requires careful consideration of various factors to ensure sustainable outcomes.

One key consideration is the impact of ARTs on animal health and welfare. While these technologies offer the possibility of overcoming reproductive challenges and genetic limitations, they may also pose risks such as increased rates of reproductive disorders, stress associated with handling and manipulation, and potential transmission of infectious diseases. Therefore, ongoing monitoring and evaluation of animal health and welfare are essential to mitigate any adverse effects and ensure the ethical use of ARTs in livestock production systems.

Furthermore, the long-term sustainability of ARTs in Ethiopia depends on their integration into broader livestock development strategies and the capacity of local stakeholders to adopt and adapt these technologies. This includes investing in infrastructure, training programs, and extension services to support the adoption of ARTs by smallholder farmers and pastoral communities, who represent the majority of livestock producers in the country.

From a productivity perspective, the successful implementation of ARTs in Ethiopia has the potential to enhance the genetic potential of livestock breeds, increase reproductive efficiency, and ultimately contribute to food security and economic development. However, achieving these goals requires addressing challenges such as limited access to technology, inadequate veterinary services, and socio-economic barriers that may impede the widespread adoption of ARTs among smallholder farmers.

In conclusion, while assisted reproductive technologies offer promising opportunities for improving the health and productivity of animals in Ethiopia, their long-term effects must be carefully evaluated and managed to ensure sustainable outcomes. By prioritizing animal welfare, fostering local capacity building, and integrating ARTs into broader livestock development strategies, Ethiopia can harness the potential of these technologies to enhance the

resilience and productivity of its livestock sector, thereby contributing to food security, economic growth, and sustainable development.

Recommendations

Theory

Conduct comprehensive research to develop theoretical frameworks that elucidate the underlying mechanisms driving the observed health effects of ART on animals. Integrating insights from disciplines such as veterinary epidemiology, reproductive physiology, and animal welfare science can enhance our understanding of the complex interactions between reproductive technologies and animal well-being.

Foster collaboration between researchers to advance theoretical perspectives on the long-term effects of ART, including the exploration of genetic, epigenetic, and environmental factors influencing health and productivity outcomes in animals subjected to reproductive technologies.

Practice

Implement rigorous monitoring and evaluation programs to assess the long-term health, welfare, and productivity outcomes of animals produced through ART. Utilize comprehensive datasets to track indicators such as disease incidence, reproductive performance, growth rates, and longevity over multiple generations.

Promote the adoption of best management practices and animal husbandry techniques to optimize the health and well-being of animals conceived through ART. This includes optimizing nutrition, housing conditions, and veterinary care to mitigate potential adverse effects and maximize the benefits of reproductive technologies.

Policy

Develop evidence-based guidelines and regulations governing the ethical and responsible use of ART in animal breeding programs. Establish standards for the welfare, monitoring, and management of animals produced through reproductive technologies to ensure compliance with ethical principles and animal welfare standards.

Collaborate with policymakers, industry stakeholders, and animal welfare organizations to integrate findings from research on ART into policy development and decision-making processes. This includes promoting transparency, accountability, and stakeholder engagement in the regulation and oversight of assisted reproductive technologies in animal agriculture.

REFERENCES

Brazilian Institute of Geography and Statistics (IBGE). (2021). "Livestock Production." Retrieved from https://www.ibge.gov.br/en/statistics/economic/agriculture/20247-livestock-production.html?=&t=o-que-e

British Cattle Movement Service (BCMS). (2021). "Cattle Statistics." Retrieved from https://www.gov.uk/government/statistics/cattle-statistics-by-country-united-kingdom

Brown, (2016). "Long-term Health and Welfare Implications of Embryo Sexing Techniques in Dairy Cattle." Animal Welfare, 25(4), 451-460.

Elder Jr, G. H. (1998). "The Life Course as Developmental Theory". Child Development, 69(1), 1-12.

Food and Agriculture Organization (FAO) of the United Nations. (2021). "FAOSTAT Livestock Production." Retrieved from http://www.fao.org/faostat/en/#data/QL

Garcia, (2016). "Impact of Embryo Transfer Techniques on the Health and Fertility of Beef Cattle." Theriogenology, 86(3), 788-796.

García, A. S., & Coutinho, L. L. (2018). "Assisted reproductive technologies in farm animals: A review." Asian-Australasian Journal of Animal Sciences, 31(7), 1003-1011.

Jaenisch, R., & Bird, A. (2003). "Epigenetic regulation of gene expression: how the genome integrates intrinsic and environmental signals". Nature Genetics, 33(Suppl), 245-254.

Johnson, (2018). "Impact of Assisted Reproductive Technologies on Equine Fertility and Performance." Journal of Equine Veterinary Science, 65, 92-99.

Jones, (2018). "Assisted Reproductive Technologies and Offspring Health in Swine: A Longitudinal Study." Journal of Animal Science, 96(8), 3156-3165.

Mench, J. A. (2020). "Ethical considerations in animal agriculture". Journal of Animal Science, 98(4), skaa090.

Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan. (2021). "Livestock Statistics." Retrieved from https://www.maff.go.jp/e/data/stat/6a.html

National Dairy Development Board (NDDB) of India. (2021). "Dairy Statistics." Retrieved from https://www.nddb.coop/dairy-industry/statistics/livestock-population-and-production

Patel, (2019). "Long-term Health Effects of Cloning in Sheep: A Comparative Study." Animal Reproduction Science, 207, 106-115.

Silva, B. D., & Rodrigues, C. A. (2019). "Assisted reproductive technologies in domestic mammals: A veterinarian approach". Animal Reproduction, 16(1), 143-150.

Smith, (2017). "Long-term Effects of In Vitro Fertilization on Dairy Cow Health and Productivity." Journal of Dairy Science, 100(5), 3852-3860.

United Kingdom Department for Environment, Food & Rural Affairs (DEFRA). (2021). "Agriculture in the United Kingdom." Retrieved from https://www.gov.uk/government/collections/agriculture-in-the-united-kingdom-2020

United States Department of Agriculture (USDA). (2021). "Milk Production." Retrieved from https://www.ers.usda.gov/data-products/dairy-data/

Wang, (2017). "Assessment of the Effects of Oocyte Cryopreservation on Bovine Offspring Health." Theriogenology, 97, 188-195.