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The Success Rate of Frozen Jersey Embryos in Rwanda: A case Study of Songa RAB Cattle Farm in Huye District

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Abstract

Milk and animal products are in high demand as the population grows and the economy prospers. Embryo technology is one of the technologies recommended for expanding access to improved dairy cattle. Challenges of the Rwanda dairy industry include low-producing cattle genetics, which results in the need to import live animals, semen, and embryos. This study investigated the embryo success rate at the Songa RAB farm between March and August 2024. Out of 62 potential recipients, 41 met experimental study parameters, including cycling, body condition score, body weight, reproductive history, and age. The cows and heifers that met selection criteria were treated with hormones to induce oestrus heat and only 17 animals had a suitable corpus luteum size to receive embryos. The pregnancy rate was determined at 90 days after implantation using ultrasonography. The collected data were analyzed via SPSS. 23. The study's findings revealed that only 29.4% of embryo transfers resulted in pregnancy. In the present study, size of the corpus luteum, recipient age, and frequency of observed heat signs were strongly correlated with a higher success rate. Despite its relevance in lowering the cost of importing live cows, minimizing animal disease transmission, and providing other economic benefits, ET technology is not commonly used, particularly in developing countries. Even though embryo technology has financial and technical barriers, it can still be recommended as an alternative method of integrating pure breeds into Rwanda's dairy development strategies.

Introduction

Embryo transfer is a process of transferring an embryo collected from a donor cow to another female (recipient) to complete the gestation period. This technique was first tested on rabbits and then on cattle, where it proved successful, particularly in developed countries (Kugonza et, *al.*, 2013). This technology is critical in the dairy sector because it accelerates the dissemination of high genetic merit cattle by maximizing the reproduction potential of the donor cow, and saves money over purchasing a live animal that may struggle to adapt to a new environment. Despite its importance, embryo transfer is expanding slowly, with little adoption in developing countries. This could be due to low technical expertise, economic constraints, poor success rate, and other reasons. The embryo transfer technology is proposed to be a tool to intensify livestock to keep high-performing dairy cattle and to obtain pure breeds with good performance in terms of milk production and other productive performance purposes. In Rwanda, ET was tested since 2010.

With the journey for improving milk production, the Rwandan government has implemented various initiatives, including bovine artificial insemination to improve local cattle breeds, imported exotic dairy cows, and the introduction of embryo transfer technology, in response to increasing milk yield and meeting the growing market for domestic and export dairy products. However, despite the significant increase in milk production in Rwanda from 503,130 MT in 2013 to 1,061,301 MT in 2023, the demand for milk still exceeds the current milk supply (MINAGRI, 2022). The Jersey cattle breed originated from Jersey Island and is reared all over the world for milk production. In Africa, the Jersey cattle breed was introduced around 1880 in South Africa and gradually spread to other countries through crossbreeding with native cattle breeds. Jersey cattle were first introduced to Rwanda in the 1950s at the Station of INEAC (Institut National pour l'Etude Agronomique du Congo-Belge et Ruanda-Urundi) in Nyamiyaga, Nyanza, in the Southern province of the country. The herd later formed the base population of the Songa Research farm operated by RAB (Rwanda Agriculture and Animal Resources Development Board) (Rutinywa and Van Pee, 2016). The introduction of Jersey genetics via ET in Rwanda is intended to reduce the cost of importing live bulls for semen production and live dams from abroad that cannot adapt well to new environments. The Jersey cow is indicated as the ideal dairy genetics cattle for smallholder production and commercial dairy enterprises to increase milk production in Rwanda's environment (Opoola *et al.*, 2024). The Jersey breed is characterized by its small size, low feed consumption, excellent milk production, quality milk with

high nutritional content, disease resistance, heat tolerance, and effective productive performances(Opoola *et al.*, 2024). Therefore, the current study attempted to assess the success rate of frozen Jersey embryos at Songa RAB research station in Rwanda.

Materials and Methods

Study area

This study was conducted between March 2024 and August 2024 at the Songa RAB research station in Huye district, Southern province of Rwanda. Songa is located in the country's mid-altitude zone of 1500-1600 meters, with an average annual temperature of 22 to 29 degrees celsius and 1087 mm of rainfall (Meteo Rwanda). Songa RAB station has around 392 hectares and accommodates approximately 400 cattle, including cows, heifers, and male and female calves. The rainfall pattern varies, with a short rainfall season from September to December, and a longer rainy period from March to May. The dry season extends from June until the end of August, with significant rainfall in April and May. Throughout the year, January and February have moderate weather (Kugonza, et al, .2013). In terms of farm management, cows graze on natural pasture by method of free access**.** Calves are suckled and weaned at 6 months of age, while female and male calves are kept in independent herd management groups.

Recipient animals

The study's target population included cows aged below 5 years old and 60 to 150 days postpartum and heifers aged 18 months to 24 months with body condition scores ranging from three to 3.5. Out of 62 animals, 41 met the experimental investigation criteria, including 28 heifers and 13 cows. The study used different cattle breed genetics available at the station, including Ankole x Sahiwal (AS) cross, Ankole x Jersey (AJ) cross, Ankole x Frisian (AF) cross, and Ankole x Brown Suiss (AB)cross. The recipients' genital organs of the recipients were examined using manual palpation and an ultrasonographic machine to confirm ovary status. Potential recipients with a corpus luteum in the ovary and without any abnormalities in the uterus were selected and treated with oestrus induction hormones. At the time of ET, the candidates were examined for corpus luteum condition; only 17 individuals were found to be eligible for ET and were then implanted. Some cows did not respond to synchronization, while others did not develop CL to maintain gestation and therefore were disqualified. In the present research, 7-day-old frozen Jersey embryos from the United Kingdom were implanted into recipient cows. The implantation of embryos was carried out by an expert with 40 years of experience in embryo collection and implementation from the United Kingdom with the support of a local team.

Synchronization of recipient

The current study used the Prid Delta technique to synchronize recipients' estrus. During this treatment, the recipients' cows received a series of hormone treatments to synchronize their estrous cycles. This method employs the Prid Delta device as a source of progesterone, prostaglandin (PG), and gonadotropin-releasing hormone (GnRH) to better control and synchronize the estrous cycle. The synchronization protocol was as follows: day 0: Administer GnRH (Gonadotropin-Releasing Hormone) and implant the Prid delta. Day 6: Administer PG (Prostaglandin). Day 7: Remove the Prid. Day 8-11: Monitor for estrus and heat signs. Day 16: implanting embryo**.**

Statistical analysis

The collected data were recorded and cleaned using Microsoft Excel spreadsheet. The cleaned data were imported and analyzed using SPSS, 23. The difference was considered as being statistically significant when the p-value was less or equal to 0.05 ($p \leq 0.05$).

Results and discussions

The success rate of frozen Jersey embryos in this study was 29.4%. This study's findings differ from the observation made by (Kugonza, *et, al*, .2013) who reported a pregnancy rate of 41% in Rwanda. the current findings are also in contrast with results observed in Netherlands by which reported 56.1% in frozen embryos and 58.4% in different locations in United States of America by (Lamb, 2011). The variation of the ET pregnancy rate might be different from one production system to another. The highest pregnancy rate is likely in intensive commercial dairy farming and less in extensive management systems. Cows in good management; transferring high-quality fresh embryos to suitable recipients might result in pregnancy rates of approximately 80% (Hasler, 2004). Reproductively healthy cows, easy calving, mothering abilities, proper feeding, disease management, and a good selection of recipients are key contributing factors to ET's success rate (Schmidt, 2010). The study findings showed the pregnancy rate was scanty compared to other studies that used frozen and fresh embryos (Hasler, 2004). This might be due to poor management of cows on the farm where cows depend on grazing without any supplementation and management input. To enhance success rate of embryos at Songa Research Center, proper

management of cows that are pretended to be recipients is critical in terms of feeding, and further selection of cattle with good mothering ability history will lead to recipient suitability for ET.

The present study revealed the impact of heat sign frequency on bovine embryo transfer in the study area. The highest success rate of 100% was observed on cows that showed clear mucus and mounted by others, and 50% for cows showed mounting others, mounted by others, and clear mucus respectively (Table1). The lowest conception rate was observed on cows that expressed one heat sign. This might be linked to previous studies that showed the contribution of more estrus signs on the pregnancy rate of bovine artificial insemination, which may contribute to a success rate of ET (Twagiramungu *et al.*, 1995). The more heat signs, the more hormones for maintaining pregnancy. The cows that showed more than two signs of heat expressed a good corpus luteum (CL) during implantation. This might be linked to an increase in hormones like luteinizing hormone (LH) that influence the heat signs intensity (Twagiramungu *et al.*, 1995).

ET pregnancy rate in the study area was proportional to corpus luteum size. The size of the corpus luteum (CL) can affect significantly the pregnancy rates of embryos. According to current findings, larger corpus luteal is associated with higher pregnancy rates. The corpus luteum plays an important role in early pregnancy as it produces progesterone, which helps maintain an appropriate atmosphere in the uterus for the developing embryo. The highest conception rate of 50% was observed in cows that showed big CL during implantation and the lowest pregnancy rate of 11.1% was observed in cows that developed medium CL. The findings of this study are similar to the observation made in Nashville United States of America by (Lamb, 2011) which reported the impact of increasing luteal tissue volume on increasing progesterone concentration level needed to maintain pregnancy.

Age is another factor that contributes to ET pregnancy rate. Pregnancy outcomes are generally better for younger recipients than older recipients. This study showed a high conception rate of 50% in cows under two years, and a reduced success rate of 22.2% in cows aged two to four years (Table 1). The higher the age, the lower the success rate, and vice versa. The study results are comparable to the findings reported by Biruh, 2020, who demonstrated that the pregnancy rate would reduce as age increased and increase when the recipient's age decreased. It is hypothesized that puberty heifers dominate cows in terms of the success rates of embryos. According to (Hasler, J. 2004 &Wilson, 2000), the success rate via ET was 73.05% in virgin heifers and 73% in mature heifers. This could be because mature heifers are more likely to maximize their hormone reproduction capacity following heat induction, but premature heifers are still too late for them to produce enough hormones to maintain pregnancy. Heifers are also less susceptible to reproductive complications that could arise during breeding and calving.

The breed of the recipient is another contributing factor that influenced the success rate significantly. A poor success rate was observed in local breeds (AA). The highest success of 100% was reported in Ankole x Brown Suiss cross followed by 60% of Ankole and Sahiwal genetics (AS) and 20% Ankole Frisian (AF) genetics respectively.

Table 1. Parameters Associated with embryo transfer Success rate

Variables		Frequency	Success rate (%)	*P-Value*
Breed	AJ	1	0	0.118
	AF	5	20	
	AS	5	60	
	AA	5	0	
	AB	1	100	
Parity	Heifer	12	25	0.536
	Cows	5	40	
Age	Under 2 Years	6	50	0.319
	2 to 4 Years	9	22.2	
	Above 4 Years	2	0	
CL Site	Right CL	7	28.6	0.949
	Left CL	10	30	
BCS	3	10	20	0.309
	3.5	7	42.9	
CL **Status**	Presence of medium CL	9	11.1	0.079
	Presence of big with CL	8	50	
Observed heat signs of recipient	Mounting others	5	0	0.062
	Clear mucus	3	0	
	Mounted by others	3	33.3	
	Clear mucus and mounted by others	2	100	
	Mounting others, mounted by others and clear mucus	4	50	
Overall, Success rate			**29.40%**	

The study findings are similar to those published by Hill (2024), who found 35% in Holstein and Jersey crossbreed and 20% in Holstein. In this study, crossbred cows were more likely to perform than indigenous cattle breeds. This report differs from the findings reported by (Mebratu, 2020), who predicted a higher success rate in Boran (indigenous breed). The low success rate of indigenous breeds could be linked to observations from AI practitioners in Rwanda, who claim poor response via induction heat for indigenous cows compared to crossbred genetics.

Conclusion

The study was designed to determine the success rate of frozen Jersey embryos in Rwanda. The study found that the recipients' age, breed, and responsiveness during synchronization impact the ET success rate. Although embryo transfer is expensive in developing countries, such as Rwanda, it is now more profitable than importing live animals. The current study found that ET technology is feasible and has the potential to make a significant contribution and accelerate dairy cow improvement. Improving herd management and community awareness about embryo technology would result in genetic improvement at minimal expense. In addition, through further research, good partnerships between dairy industry companies, governments, and institutions might be a way to equip local teams to perform well embryo transfer.

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