DAIRY CATTLE BREED PREFERENCE AND SOCIO-ECONOMIC IMPACTS OF THE SMALLHOLDER DAIRY CATTLE FARMING SYSTEM IN RWANDA

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ABSTRACT

Smallholder dairy farming systems serve as the backbone of rural economies in many African countries, providing households with food security and income while also developing assets. The purpose of this study was to examine dairy cattle breed preferences and determine the economic impacts of smallholder dairy farming systems in Rwanda. A household survey was conducted in nine districts of Rwanda using a random sampling method to collect quantitative data from 411 smallholder dairy farmers. Data were collected in Microsoft Excel and processed with the Statistical Package for Social Science, version 26. The data showed that the most preferred dairy breed among smallholder dairy farmers was Jersey cross (44%), followed by a Friesian cross (28.2%). The findings also revealed that 65.8% of respondents kept at least one dairy cow, which had some social and economic consequences such as providing milk for home consumption (99.6%), income from selling manure and cattle (98.7%), manure for land fertilization (97.1%), employment (95.5%), social respect (91.3%), health service (88%), asset development (87.5%), education service (81.5%), and social security contribution (39.2%). The study's findings demonstrated the importance of the smallholder dairy farming system in boosting household welfare, creating social cohesion, and empowering marginalized groups, and supporting economic stability. Further research is needed to determine the factors influencing dairy breed selection among smallholder dairy farmers in Rwanda, as well as their relative significance.

Key words: dairy breed preferences, dairy cattle breeds, smallholder farmers, socio-economic impacts

INTRODUCTION

Rwanda is one of the most densely populated countries in Africa with around 13.2 million people occupying 26,338 square kilometers of land and agriculture is a backbone activity that improves the livelihoods of citizens (NISR, 2022). Dairy as an agricultural activity is a primary livelihood provider for smallholder farmers especially those who live in rural and sub-urban places in Rwanda (NISR, 2022). The Dairy sector is a key income source for many smallholder farmers in providing job opportunities and generating revenue. Besides selling milk, dairy farming supplements crop production by providing manure for land fertilization, which acts as nutrients for crop growth thus enhancing agricultural integration. The government of Rwanda has initiated various interventions to ensure food security and raising household incomes by encouraging farmers to venture into the dairy sector as a basic activity to provide livelihoods and meet modern farming that is market-driven (Perez-Guzman *et al.,* 2023). These interventions include genetic improvement of indigenous cattle through artificial insemination, one cow per poor family policies, decentralization of milk collection centers, and milk-processing plants across the country (MINAGRI, 2023). From 2006 when one cow per poor family and other interventions started, the number of bovines increased from 1,135,141 to 1,644,692 cows, and currently dairy cattle population is mostly comprised of crosses of Friesian and Jersey with indigenous breeds (NISR, 2022). These genetic improvements, alongside improved management practices increased milk from 503,130 metric tons in 2006 to 1,061,301 metric tons in 2023 (MINAGRI, 2023).

However, due to limited land and high demographics, land for agriculture is significantly becoming rare, and farmers tend to depend on smallholder farming practices. According to a study done in Tanzania (Mzingula, 2019), a smallholder dairy

farmer is defined as a farmer with a small plot of land and few cows who lives on integrating crop production and dairy farming in that small particular plot.

Thus, this study attempted to assess demographic characteristics of smallholder dairy cattle farmers, farmer's preferences for dairy cattle breeds, and identify the socio-economic impacts of smallholder dairy farming systems in Rwanda. This paper contributes to the on-going debates about the most favorable dairy breed for smallholder dairy farmers in Eastern Africa and the socio-economic impacts of smallholder dairy farming systems with a focus on Rwanda. Finally, this paper provides practical policy and research recommendations.

MATERIALS AND METHODS
Study Area and Data Collection
This study relied on quantitative analysis. It was conducted in Rwanda, a country located in eastern Africa between latitudes 1° 04' and 2° 51' S, and longitudes 28° 45' and 31° 15' E (Hirwa *et al.*, 2022). The data used were based on a survey that was designed and collected through a survey questionnaire. Two rounds of survey were conducted during this data collection period. The first round occurred between May 01, 2024 to May 15, 2024, and the second round from June 01 to July 01, 2024. The data comprised a demographic characterization of respondents,

preferences for dairy breeds, and socio-economic impacts of dairy farming among smallholder dairy farmers in the study locations. A total sample of 411 households was randomly selected across nine districts in all four provinces of Rwanda, plus peri-urban areas of the City of Kigali. In Eastern province, surveys were conducted in Rwamagana and Kayonza districts, in Southern province, data were collected in Huye and Nyanza districts, survey data were also collected in Rubavu and Nyabihu districts of the Western province, and Rulindo and Gicumbi districts in the Northern province. In Kigali, the survey data were collected in Gasabo district. This study used a two-stage analysis to find patterns and meanings in the collected data. First, the survey data were entered into the Microsoft Excel 2016 software. The entered data were then screened for errors and corrected by verifying against the original data forms. Second, data analysis was performed using the Statistical Package for Social Sciences and presented as tables, graphs, and charts.

RESULTS AND DISCUSSION
Demographic Characterization of Respondents
A demographic characterization of survey respondents is shown in Table 1. The findings revealed that 62.8% of smallholder dairy cow owners were male, while 37.2% were female. These

Table 1: Demographic characteristics of smallholder dairy farmers households in the selected provinces and Kigali city

Demographic characteristics	East (*n* = 64)	North (*n* = 145)	Kigali (*n* = 27)	South (*n* = 89)	West (*n* = 86)	Total (*n* = 411)
Gender						
Male	54.70	63.40	48.10	70.80	64.00	62.80
Female	45.30	36.50	51.90	29.20	36.00	37.20
Marital status						
Married	70.30	80.70	77.80	82.00	90.70	81.30
Divorced	4.70	0.00	0.00	1.10	1.20	1.20
Single	0.00	4.80	0.00	9.00	2.30	4.10
Widowed	25.00	14.50	22.20	7.90	5.80	13.40
Age of respondent						
18 to 35 years old	9.40	9.00	3.70	19.10	18.60	13.00
36 to 45 years old	23.40	31.70	55.50	33.70	23.20	30.60
46 to 60 years old	37.50	38.60	29.70	21.40	29.10	32.10
Above 60 years old	29.70	20.70	11.10	25.80	29.10	24.30
Education						
Bachelor's degree	3.10	2.80	0.00	0.00	7.00	3.00
Upper secondary school	4.70	7.60	0.00	3.40	5.80	5.30
Lower secondary school	25.00	23.50	29.60	15.70	11.60	19.90
Primary school	46.90	56.50	63.00	56.20	38.40	51.60
None	20.30	9.60	7.40	24.70	37.20	20.20
Sources of income						
Dairy farming only	100.00	100.00	100.00	100.00	100.00	100.00
Crop production and dairy	100.00	95.90	100.00	100.00	93.00	97.10
Small livestock farming and dairy	70.30	62.70	55.50	55.00	39.50	56.90
Public employment	1.60	0.70	0.00	0.00	0.00	0.50
Private employment	0.00	1.40	0.00	1.10	2.30	1.20
Others	1.60	2.70	0.00	0.00	0.00	1.20
Land size						
Below 0.5 ha	53.10	43.40	96.30	49.50	78.00	57.00
0.6 to 1 ha	42.20	53.80	3.70	46.10	21.00	40.10
1.1 to 1.5 ha	4.70	2.80	0.00	2.20	1.00	2.40
1.6 to 2 ha	0.00	0.00	0.00	2.20	0.00	0.50
Number of cows						
1	81.20	62.70	40.70	65.20	67.40	65.80
2 to 3	18.80	35.90	59.30	32.60	32.60	33.30
4 to 5	0.00	1.40	0.00	1.10	0.00	0.70
5 to 10	0.00	0.00	0.00	1.10	0.00	0.20

results align with previous studies on the demographics of smallholder dairy farmers (Lwelamira *et al*, 2010; Ongwech *et al.,* 2020) who highlighted that women are minority participants in smallholder dairy production. This disparity may be attributed to household gender and power dynamics, where men, often regarded as heads of households, are more likely to own dairy cows. The study revealed that ca. 81% of respondents involved in smallholder dairy farming were married, while only 1% were divorced. These findings suggest a strong association between marital status and participation in dairy farming. Marriage may play a pivotal role in fostering stability and resource sharing, which are crucial for engaging in agricultural activities like dairy farming. Married individuals are likely to benefit from shared responsibilities and decision-making, potentially enhancing the efficiency and sustainability of their farming operations. These results align with the findings of Ongwech *et al.* (2020), who reported that 69.57% of married smallholder farmers in Tanzania were actively engaged in dairy farming. This similarity underlines the importance of familial and marital structures in supporting smallholder agricultural practices across different regions of Africa including Rwanda.

The study revealed that Rwandan adults aged 36 to 60 are the most actively engaged demographic in agriculture and related economic activities, accounting for 62.7% of participation. This finding highlighted the significant role of this age group in driving the agricultural sector, likely due to their resourcefulness, experience, and economic productivity. Individuals in this age range are typically at the peak of their working years, with accumulated knowledge and access to resources that enable them to actively engage in farming. In contrast, only 13% of young people under 35 years old are involved in dairy farming. This may be attributed to several factors, including the fact that many young people are still in school, graduates are seeking employment opportunities outside of agriculture, and some face financial barriers that may prevent them from acquiring farming land.

The findings indicate that only 3% of respondents attended university, 25.2% completed secondary school, 51.6% finished primary school, and 20.2% were illiterate. This suggests that formal education may not be a critical factor in farming business performance, as most farmers in the study had relatively low educational attainment. However, it is worth noting that some respondents possess educational backgrounds ranging from primary education to university equipping them with the knowledge to implement effective agricultural practices and business strategies. This finding also aligns with the general trend in previous literature, which repeatedly highlighted a low number of smallholder dairy farmers who reached the university level, particularly in sub-Saharan Africa

(Lwelamira *et al*, 2010). A relatively high percentage of illiterate dairy farmers might be attributed to the historical contexts of Rwanda that limited the number of people attending school in the pre-genocide period.

The study revealed that most respondents owned < 0.5 ha of land (57%) and kept at least one dairy cow (65.8%). Many participants explained that the limited land size constrained their ability to increase and expand dairy productivity. These findings differ from those of Ngongoni *et al.* (2006) in Zimbabwe, where smallholder dairy farmers typically owned more than 0.5 hectares of land and at least one cow. Unlike the current study, access to land was not identified as a significant challenge in Zimbabwe and other eastern and southern African countries.

Farmer Perception on Dairy Breed Preferences
The full sample results shown in Figure 1 revealed that Jersey crosses (44%) are the most preferred dairy breed among smallholder farmers, followed by Friesian crosses (28.2%). These findings highlighted a strong preference for crossbred cattle over purebred. The relatively low preference for purebred Friesian and Jersey cattle can be attributed to several factors, including their limited availability and the management challenges associated with maintaining pure breeds in smallholder systems. The high preference for Jersey crosses may be explained by their favorable traits, as supported by earlier research conducted in Rwanda by Opoola *et al.* (2022) and Rwamuhizi *et al.* (2024), who noted that Jersey cattle show exceptional feed efficiency, ease of management, and resilience to common challenges faced by smallholder farmers. Additional advantages include their disease resistance, high fertility rates, and adaptability to diverse farming conditions. These preferences reflect a logical approach by smallholder farmers who prioritize breeds that offer a balance of productivity and manageability. The limited preference for pure breeds suggests that smallholder farmers may perceive them as less practical due to higher maintenance costs, specialized feeding requirements, and susceptibility to diseases. This observation underscores the importance of breeding programs that focus on improving crossbreed availability and accessibility while addressing the practical needs of smallholder farmers.

The study findings are in contrast with previous findings report by Bebe *et al.* (2003), who reported that in most highland areas the Friesian breed was the most preferred breed by smallholder dairy farmers in eastern Africa. The difference in dairy breed of choice might generally be linked to factors such as availability of land, production system types, and availability of production inputs (Kahi *et al.,* 2000). This might be because Friesian cattle have been the only exotic breed widely marketed in many breeding initiatives, which has influenced farmer choices and the breeding environment in places like
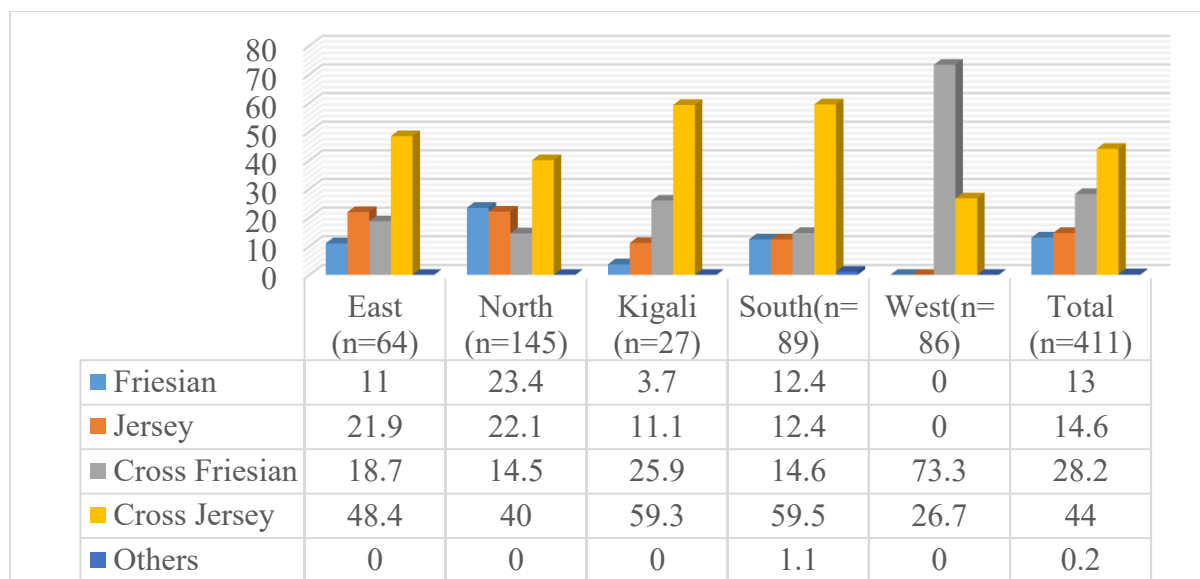
	East (n=64)	North (n=145)	Kigali (n=27)	South(n= 89)	West(n= 86)	Total (n=411)
■ Friesian	11	23.4	3.7	12.4	0	13
■ Jersey	21.9	22.1	11.1	12.4	0	14.6
■ Cross Friesian	18.7	14.5	25.9	14.6	73.3	28.2
■ Cross Jersey	48.4	40	59.3	59.5	26.7	44
■ Others	0	0	0	1.1	0	0.2

Figure 1: Breed preferences in the study area

Ethiopia, where crossbreeding programs have mostly focused on Friesian genetics to increase productivity. Despite producing more milk, Friesian cattle are more economically vulnerable due to their higher resource needs in terms of feeds, healthcare, and overall management to reach their full production potential and susceptibility to environmental stress (Rwamuhizi *et al.,* 2024). The findings of this study revealed that access to purebred Friesians and Jerseys is limited for smallholder farmers due to their high cost, leading to a preference for crossbred Friesians and Jerseys, which are more affordable and better suited to smallholder farming systems.

The higher preference for Jersey genetics observed in this study can be also attributed to the survey's geographic focus on the Eastern, Northern, and Southern districts, where targeted dairy interventions have been implemented. These interventions, including the Jersey Inka Nziza Project, Heifer International Programs, and the Rwanda Dairy Development Initiative, have likely enhanced awareness of the Jersey breed and highlighted its profitability in dairy farming systems. Conversely, the Western province demonstrated a significantly higher preference for Friesian cattle genetics. This trend may be attributed to the absence of dairy-focused initiatives promoting alternative breeds, such as Jersey cattle, in the region. Additionally, the higher preference for Friesian cattle genetics could be influenced by historical and cultural factors favoring larger-sized cattle, which align with the physical characteristics of Friesian cattle breed. These factors coupled with the absence of targeted interventions to demonstrate the profitability of alternative dairy breeds may influence higher preference for Friesian genetics, which dominate dairy cattle populations in the Western province and possibly other regions of the country.

Reasons for Dairy Cattle Breed Preferences
The reasons for respondents' dairy breed preference are shown in Table 2. The current findings revealed that the most common reasons for farmers preferring pure Friesian and Friesian cross breeds are based on marketing, size of animal, and milk yield. Other results from respondents illustrated that smallholder farmers prefer pure Friesian and Friesian cross cattle due to their big size at 98.9%, good market returns for young calves at 98.9%, and good market for mature cows. On the other side, reasons highlighted by the survey respondents for Jersey breed preferences include feeding management, quality of produced milk, and disease resistance for this breed type. Other reasons for the choice of pure Jersey and Jersey cross preferences, included the fact that the Jersey genotype eats small amounts of feed (95.9%), produces good quality milk (92%), is disease tolerant (93.8%), docile (93.8%), higher preference of milk at a local market (65.5%) and other reasons like easy calving and being a friendly breed (48.2%).

Social and Economic Impacts of Smallholder Dairy Cattle Farming on Improving Livelihood
With regard to the economic impacts of smallholder dairy cattle farming in the surveyed regions, the findings of this study in Figure 2 indicated that smallholder dairy farming contributes to improved household incomes. Dairy farming households in the surveyed areas earned income through sales of milk, manure and cows to their respective markets. The results indicated that 90% of the respondents highlighted that dairy cattle farming generated income via milk sales while 98.7% indicated that they generate income from selling manure and cattle. Survey respondents also pointed out that revenues from dairy farming are used to acquire household necessities such as paying for school fees (81.5%), healthcare services for dependents (80%) and social

Table 2: Reason for dairy cattle breed preferences

|	East (n = 64)	North (n = 145)	Kigali (n = 27)	South (n = 89)	West (n = 86)	Total (n = 411)
Reason for pure Friesian and Friesian cross breed preferences						
They produce high milk yield	86.30	82.10	84.80	88.40	90.60	86.40
They produce good-quality milk	52.70	54.70	60.40	69.20	58.90	59.20
They have high fertility rate	65.00	66.40	62.30	64.90	67.60	65.20
They have short postpartum anestrus	67.50	70.20	71.20	75.90	77.80	72.50
They are diseases tolerant	40.80	42.30	38.40	42.30	47.30	42.20
Their longevity	62.30	64.70	66.30	68.50	69.90	66.30
Adaptable to wide range of environments	58.30	60.10	73.90	75.40	79.30	69.40
One calf per year	61.70	65.90	60.30	63.60	62.90	62.90
Climate change adoption	66.20	63.40	70.20	69.30	72.40	68.30
Big size	99.50	99.30	98.70	97.80	99.30	98.90
Good market for young male calf	98.30	99.10	99.40	98.40	99.50	98.90
Good market for mature cows	97.40	98.20	98.90	98.10	97.90	98.10
Others (good color and available breed)	39.00	42.90	41.50	42.90	45.80	42.40
Reason for pure Jersey and Jersey cross-breed preferences						
They eat in small amounts of grasses	98.00	98.60	97.30	98.40	87.30	95.90
They produce high milk yield	79.60	80.30	78.30	80.20	81.60	80.00
They produce good-quality milk	98.00	97.80	97.60	82.50	83.90	92.00
They have high fertility rate	78.00	81.20	80.20	85.40	76.30	80.20
They have short postpartum anestrus	80.00	82.30	78.20	80.00	79.40	80.00
They are diseases tolerant	93.00	94.70	94.10	92.10	95.20	93.80
Their longevity	65.70	70.50	68.40	73.50	75.30	70.70
Adaptable to wide range of environments	91.40	90.10	89.30	89.20	87.50	89.50
High preferences for the milk at the local market	48.20	52.80	62.70	84.30	79.40	65.50
One calf per year	77.30	78.90	73.50	77.90	70.20	75.60
Climate change adoption	84.60	88.20	87.30	89.20	88.20	87.50
Easy to manage	95.50	96.40	97.10	97.40	98.50	97.00
They are docile	91.20	93.10	92.40	95.50	96.70	93.80
Good market for mature cows	69.40	68.00	63.20	60.30	54.50	63.10
Others (friendly and easy calving)	41.90	47.90	51.50	49.20	50.30	48.20
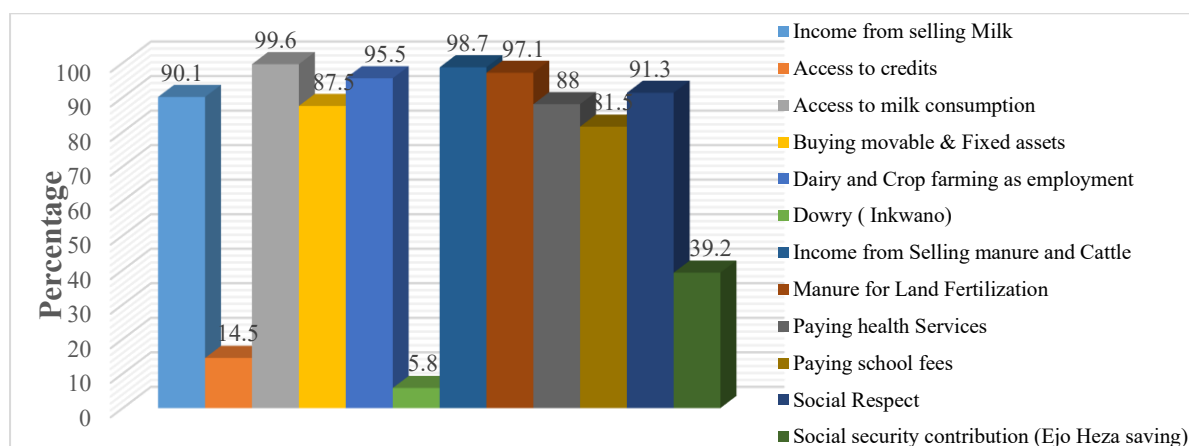
Figure 2: Social and economic benefits of dairy cattle in smallholder production system

security contributions (39.2%). Overall, these results further support previous findings on the socio-economic benefits of smallholder dairy farming (Somda *et al.,* 2005; Espinoza-Ortega *et al.,* 2007; Ongwech *et al.,* 2020) and imply that dairy farming in smallholders leads to economic development and access to finance (Frigot and Norgaard, 2013).

The findings in Figure 2 revealed the role of dairy farming in ensuring households food security as indicated by 99.6% of the respondents. According to the respondents, milk provides a reliable source of nutrients through consumption of milk and other dairy products. Furthermore, 90.1% respondents reported that the income from milk sales supported them in acquiring social welfare services such as health insurance and provided an opportunity to be able to participate in saving schemes (Figure 2).

Survey respondents illustrated the shifts in cultural benefits of dairy farming. The current data revealed that dowry through cows is very low 5.8% in comparison to other socio-economic potentials of dairy cows in study areas, but a dairy cow is currently considered a symbol of social respect at 92.3% in study locations (Figure 2). The findings of this study further support the results obtained by Frigot and Norgaard (2013), Mzingula (2019), and Banda *et al.* (2021) in Tanzania and Malawi, who highlighted smallholder dairy farming as a crucial pathway for socio-economic development. One potential reason for this statement is the ability of dairy farming to create jobs directly on farms and indirectly throughout the dairy value chain (Mzingula, 2019; Banda *et al.,* 2021).

In addition to the social benefits, smallholder farmers were able to access fixed and movable assets for home use (87.5%). These results reflect those reported by Bebe *et al.* (2003), who reported a significant socio-economic impact of smallholder dairy farming as a source of food security, fighting against malnutrition, manure for land fertilization, and contributing to life insurance and financial stability. This indicates that dairy farming provides not just a source of income but also long-term stability and resource accumulation, which are critical for resilience in rural communities. These findings are also consistent with that of Sekhar *et al.* (2017), which found that dairy cattle had a social and economic impact in rural-urban areas. In the context of Rwanda, the success of integration of smallholder dairy and crop farming as primary sources of income in Rwanda could be attributed to limited land followed by higher demography, which put pressure on smallholder farmers to optimize their profits from farming.

CONCLUSION
This study aimed to assess demographic characteristics of smallholder dairy cattle farmers, farmer's preferences for dairy cattle breeds, and identify the socio-economic impacts of smallholder dairy farming systems in Rwanda. Informed by a quantitative analysis of insights from a total sample of 411 households, randomly selected across nine districts in all four provinces of Rwanda, plus peri-urban areas of Kigali, this study highlighted Jersey as the most popular breed, followed by the Friesian breed. Factors such as disease resistance, high milk quality, a good market for milk in the local context, eating less feed, and other managerial benefits were the main reasons for study participants to choose Jersey as their most favorable breed. Friesian preferences were primarily focused on large size and a good market for both calves and adult cows. On the socio-economic aspect, this study indicated that smallholder dairy farming is a vital part of the national economy since it creates jobs both directly and indirectly, builds assets, strengthens social bonds, and improves food security and economic stability. Dairy farming is seen by farmers as a significant source of revenue. Suggestions to ensure a crop and dairy farming integration system at the smallholder level can provide good socio-economic returns to smallholder dairy farmers. To encourage additional socio-economic impact in smallholder farming, this study further suggests that policy interventions to prioritize comprehensive extension services that may provide farmers with the knowledge they need to maximize profits and boost dairy farming revenue on the available limited land. Lastly, to guarantee steady integration of crop and dairy production, a thorough approach that addresses land use management, financial loss from feeding, and health management through the adoption of Jersey genetics and demographic pressure is a logical and practical option proposed by this study.

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