Assessment of Preferable Breeding Method Use and Related Limitations under Smallholder Dairy Farmers’ Conditions: A Case Study in Selected Districts Southern Highland Zone of Tanzania

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ABSTRACT

A study was carried out to assess status and preference of smallholder dairy farmers on breeding method use under smallholder dairy cattle production in Southern Highland zone of Tanzania. Three districts namely Njombe, Mbeya and Mbozi were purposively selected for data collection. Data were collected using a questionnaire. A total of 180 dairy farmers in three districts were voluntary interviewed. Results showed that many of dairy farmers’ age range between 41 to 50 years (33%) of respondents, 48% of respondents had primary education, many farmers were found not to be working in groups (82.2%) and majority had never received any training on dairy husbandry (81.1%).

Zero grazing was the main management system (97.2%) used by farmers in all districts. Cows’ sheds were partially roofed, and the floors were soiled (48.9%). Mean dairy herd size was 5.21 per household and natural service was the predominant breeding method (55%) under smallholder farms production system. Farmers’ main reason for using AI was to improve genetic potential of their animal (48.8%). Under this system the major challenges of AI service were inefficient semen supply and poor heat detection. Natural services are widely used since it is easily accessible and cheaper. It therefore concluded that use of natural service is still a predominant method of choice in breeding due to unreliability and inefficiency associated with AI service in the Southern Highland zone of Tanzania.

Keywords: A.I. services, dairy cattle, natural services, smallholder farmers, Tanzania shilling (Tsh).

I. INTRODUCTION

Under different livestock herd management systems farmer’s objectives are normally to keep and maintain animals which have high growth rate, attain maturity early, high fertility, produce viable calf and produce high milk yield for calves and selling. In many developing countries under small holder dairy production system these objectives are very rare to be archived and the major constraints are poor breeding programs and poor infrastructure of simple breeding technology such as AI technology. In developed countries AI service is widely used for cattle mainly dairy cattle for breeding as an immediate way of farmers to obtain better animals in a short period (genetic improvement) hence AI remains to be an important simple technology in livestock production system in the world [1]. In Tanzania AI service has been used since 1950s [2] in places such as Nation food company (NAFCO) farms, Livestock Multiplication units, prison farms, private farms and individual farms are major users of AI service in the country as their main breeding method. Although smallholder farmers have been using natural and AI services as their breeding method, but there has not been a follow up on the use of these methods in the field this is to say farmers choices and preferred breeding method are not known and their associated challenges and constraints of these breeding method are unknown too.

In general, there has been complain on the effectiveness of each method in small holder farms in various districts in the country, thus the study was undertaken to evaluate the status of the breeding method use and associated challenges in the southern Highland zone of Tanzania.

II. MATERIALS AND METHODS

A. The Study Area

The study was conducted under smallholder dairy farming system in selected three districts namely Mbozi, Njombe and Mbeya in Southern Highland land zone of Tanzania. SHZ is comprise of seven (7) regions which are Katavi, Rukwa, Songwe, Mbeya, Iringa, Njombe and Ruvuma, it borders Malawi, Mozambique, and Zambia. The zone lies between latitude 60S and 120 S and Longitude 290 E - 380 E. The area receives uni-modal rainfall pattern between 823 mm up to

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2850mm and tends to start in November and April. The annual temperatures are between 130 °C and 190 °C.

B. Data Collection and Analysis

A cross sectional and field survey was used to evaluate status of breeding methods use in small holder farmers in the three Districts (Mbozi, Njombe and Mbeya DC) in the SHZ. Structured questionnaire was designed based on the objective of the study. The questionnaire was pretested to check its reliability and validity. The questionnaire was administered through individual interview of farmer with the assistance from extension workers. Purposive sampling was used to select the three districts. These districts have conducive environment for dairy keeping in the country and use of AI service is relatively high. From each district one ward was selected and 60 farmers were randomly selected for interviewed and making a total of 180 smallholder farmer from the three districts. Information collected include respondent characteristics, Breeding methods, knowledge of farmer on heat detection, desired breeding method use, recording and cost of breeding. Information from extension workers and AI service provider were also obtained summarized and used in supporting the results from each district.

C. Data Processing and Analysis

Data from questionnaire were coded and analyzed using the statically package for social sciences (SPSS 2008) a computer software in order to generate descriptive statistics such as means and percentages. The chi-square test of independence was run to compare proportions of respondent from difference districts with respect to various responses

III. RESULTS AND DISCUSSION

A. General Characteristics of Respondents in the Study Area

Results showed that many of dairy farmers’ age range between 41 to 50 years (33%), however, in Mbeya district most respondents were younger aged between 30 to 40 years (33.3 %) (Table I). Forty eighty percent of respondents (48.9%) had primary education, followed with secondary and few had college education. Implying that they were able to read and make rational decision regarding dairy cattle improvement (Table I). Across districts, many farmers were found not to be working in groups (82.2%) and majority had never received any training on dairy husbandry (81.1%) (Table I). The results also indicated that most farmers (>50) had more than 21 years’ experience in keeping dairy cattle in all districts.

B. Grazing and Housing Description in the Study Area

In the study areas most of the farmers (97.2%) across the districts keep their animals under zero grazing system. Only 2.8% used semi-grazing whereby animals are herded during the day and zero grazed during the evening and rain season. Farmers from Mbozi district depended solely on zero grazing system (Table II). Most of animals’ sheds were made of timber walls, partial roofed with corrugate iron sheets with the earthen floors (48.9%) (Table II).

![Fig. 1. Animal housing condition in the study area.](http://dx.doi.org/10.24018/ejfood.2022.4.2.484)
C. Herd Structure and Type of Breed Kept

Farmers interviewed kept at least one dairy cattle and the mean herd size was found to be 5.21±0.29 per household. Cows were leading with higher mean of 1.89±0.07 per household and breeding bull were generally few with a mean of 0.14±0.03 per household (Table III). Friesian and Aryshire were dominant breeds. Mean sizes for these breeds were 1.64±0.07 per household and 0.62±0.08 per household respectively (Table III).

| Dairy cattle categories (n=180) | Mean herd size |
|-------------------------------|----------------|
| Bull calves                   | 0.48±0.05      |
| Heifer calves                 | 0.79±0.06      |
| Heifers                       | 0.65±0.06      |
| Milking cows                  | 1.89±0.07      |
| Dry cows                      | 0.86±0.07      |
| Breeding Bull                 | 0.14±0.03      |
| Average herd size             | 5.21±0.29      |
| Breeds                        |                |
| Friesian crosses              | 1.64±0.07      |
| Aryshire crosses              | 0.62±0.08      |

D. Dairy Cattle Breeding and Reproduction

Results from interviewed farmers across the district show that majority of farmers (65.6%) from Njombe, Mbozi districts and a few from Mbeya mate their heifers for the first time when they attain the age of 18 months (Table IV). A larger number of respondents in Mbeya (71.7%), few from Mbozi (38.3%) and Njombe (28.3%) mentioned age and sign of heat as determinant factor to mate their animals, while majority in Njombe (58.3%) and Mbozi (56.7%) mentioned heat signs as the determinant factor for the first time. It was further observed that majority of farmers in Mbeya (63.3%), Njombe (60%) and Mbozi (60%) mate their cows 3 months after calving.

TABLE IV: PROPORTION OF FARMERS’ RESPONSES ON BREEDING AND REPRODUCTION

| Variable                        | Mbeya N=60 | Njombe N=60 | Mbozi N=60 | Total N=180 |
|---------------------------------|------------|-------------|------------|-------------|
| **Age at First Service (AFS)**  |            |             |            |             |
| 18 months                       | 26 (43.3)  | 43 (71.7)   | 49 (81.7)  | 118 (65)    |
| 19 to 24 months                 | 34 (56.7)  | 17 (28)     | 11 (18.3)  | 62 (34.4)   |
| **Days from calving to First service (DCFS)** | | | | |
| 2 Months                        | 8 (13.3)   | 3 (5)       | 3 (5)      | 14 (7.8)    |
| 3 Months                        | 38 (63)    | 36 (60)     | 36 (60)    | 110 (61)    |
| 4 Months                        | 14 (23)    | 21 (35)     | 21 (35)    | 56 (31.1)   |
| **Determinant of mating**       |            |             |            |             |
| Age                             | 3 (5)      | 8 (13.3)    | 3 (5)      | 14 (7.8)    |
| Signs of heat                   | 10 (16)    | 35 (58.3)   | 34 (56.7)  | 79 (43)     |
| Age and signs of heat           | 43 (71)    | 17 (28.3)   | 23 (38.3)  | 83 (46)     |
| Health status and heat signs    | 4 (6.7)    | 0 (0)       | 0 (0)      | 4 (2.2)     |

IV. BREEDING METHOD PREFERENCE IN THE STUDY AREA

Mating method used by farmers differed between districts where the majority of farmers (55%) use Natural Service (NS), 38.9% AI service and 6.1% preferred both methods (Fig. 1). District wise about 60% of respondents in Mbozi use AI service as the main breeding method, followed by Mbeya (36.7%) and then Njombe (21.7%). Although AI has been proven as the quick and good way to improve reproduction and production efficiency adoption rate of this technology was observed to be minimal due to many limitations some of which will be presented in the following sections.

V. USE OF ARTIFICIAL INSEMINATION SERVICES AS BREEDING METHOD IN THE STUDY AREA

Slightly more than one third of farmers (35.4%) had been using AI for about 10 to 14 years, this experience in using AI differed across district, whereby most experienced farmers (48.6%) of responses were in Mbozi district, followed by Mbeya (32%) and Njombe had the least experienced farmer (18.2%) (Table V). Heat detection was mainly detected by family members (45%) and differences across district were also observed. In Mbeya district farm owners were the main ones responsible for heat detection while stockman played little role in heat detection (22%). On rating heat signs mentioned by farmers across districts mucus discharge was the most obvious sign (64.6%), followed by nervousness and restlessness (56.1%), bellowing (45.1%), stand to be mounted (32.8%) and licking vulva (8.5%) (Table V). About two third of dairy keeper (32.9%) checked heat signs once per day and more farmers checked more than once per day. In Mbeya many farmers (44%) were keener in checking heat signs and an average of four times per day was reported while in Njombe about 50% checked two times per day (Table V). The results further show that (36.6%) of farmers spent about 10 minutes every time they went for heat detection, whilst 10% of the farmers spent about half an hour.

A. Time AI Technician Arrive for Cows/ Heifer Insemination

In the study it was observed that the majority of AI technician arrived between 6 to 10 hours to service the cows/heifers after being contacted by the farmers (Table VI). Only a few (17%) AI technician arrived less than 6 hours to service cattle after a farmer observed heat signs. In general, 53.7% of the farmers in all districts did not keep records related to AI service. However, Mbeya had larger number of farmers (68%) followed by Mbozi (53.7%) and Njombe had fewer farmers (31.8%) who did not keep records. (Table VI).

![Fig. 2. Proportion of farmers’ preference on breeding method use.](image)
Table V: Proportion of farmers’ responses on AI use in the study area:

| Variable                | Mbeya (N=25) | Njombe (N=22) | Mbozi (N=35) | Total (N=82) |
|-------------------------|--------------|---------------|--------------|--------------|
| Experience using AI (years) |              |               |              |              |
| 1 to 4                  | 5 (20)       | 4 (18)        | 6 (17)       | 15 (18)      |
| 5 to 9                  | 10 (40)      | 10 (46)       | 7 (20)       | 27 (33)      |
| 10 to 14                | 8 (32)       | 4 (18)        | 17 (48)      | 29 (35)      |
| Above 14                | 2 (8)        | 4 (18)        | 5 (14)       | 11 (13)      |

Who detect heat sings:

- Stockman
- Family member
- Farm owner
- Heat signs mentioned
- Mucus discharge
- Nervous and restless
- Stand to be mounted and mount others
- Licking vulva
- Bellowing

Table VI: Proportion of farmers’ responses on arrival time of AI technician and AI records:

| Variable                | Mbeya (N=25) | Njombe (N=22) | Mbozi (N=35) | Total (N=82) |
|-------------------------|--------------|---------------|--------------|--------------|
| Time                    |              |               |              |              |
| 1 to 5 h                | 3 (12)       | 3 (13)        | 15 (42.9)    | 21 (25.6)    |
| 6 to 10 h               | 20 (80)      | 9 (40.9)      | 15 (42.9)    | 44 (53.7)    |
| Above 10 h              | 2 (8)        | 10 (45.5)     | 5 (14.3)     | 17 (20.7)    |
| AI recording            |              |               |              |              |
| YES                     | 8 (32)       | 15 (31.8)     | 15 (42.9)    | 30 (46.3)    |
| NO                      | 17 (68)      | 7 (31.8)      | 20 (35.7)    | 44 (53.7)    |

Table VII: Proportion of farmers’ response on the reasons for using AI:

| Reasons                                      | Mbeya (N=25) | Njombe (N=22) | Mbozi (N=35) | Total (N=82) |
|----------------------------------------------|--------------|---------------|--------------|--------------|
| Good genetic potential                       | 15 (60)      | 11 (50)       | 14 (40)      | 40 (49)      |
| Minimize cost of raising a bull              | 1 (4)        | 4 (18)        | 2 (6)        | 7 (9)        |
| Genetic potential and reduce cost of raising bull | 3 (12)      | 3 (13.6)      | 5 (14)       | 11 (13)      |
| Less disturbance keeping bull                | 5 (20)       | 4 (18.2)      | 5 (14)       | 14 (17)      |
| Good growth rate and health offspring         | 1 (4)        | 0 (0)         | 0 (0)        | 10 (12)      |

Table VIII: Proportion of farmers’ responses on negative perception on AI use:

| Disadvantage                                | Mbeya (N=25) | Njombe (N=22) | Mbozi (N=35) | Total (N=82) |
|---------------------------------------------|--------------|---------------|--------------|--------------|
| Increase cost in case of repeat service     | 8 (32)       | 7 (31.8)      | 3 (8.6)      | 18 (21.9)    |
| Time taken for heat follow up and increase cost in case of repeat service | 3 (12)       | 2 (9.1)       | 2 (5.7)      | 7 (8.5)      |
| Dystocio due to big size offspring          | 4 (16)       | 2 (9.1)       | 3 (8.6)      | 9 (10.9)     |
| Difficult to detect heat, few technicians and cost in case of repeat service | 8 (32)       | 3 (13.6)      | 8 (23)       | 19 (23.2)    |
| Technician arrives when post heat signs     | 1 (4)        | 1 (4.5)       | 3 (8.6)      | 5 (6.09)     |
| All above                                  | 1 (4)        | 6 (27.3)      | 16 (46)      | 23 (28)      |

Fig. 3. AI technician arriving at farmer’s location by motorcycle and other one by foot.

Fig. 4. AI Tech. inseminating a cow at farmer’s condition.

C. Farmer’s Negative Perception on AI as Breeding Method

Farmers mentioned many factors that hold them back in using AI service (Table VIII). In Mbeya, about one third of farmers (32%) observed high cost in case of repeat service and difficult to detect heat and few technicians as the reason for not readily using AI services.

In Njombe, one third of the farmers (31.8%) reported that high cost in case of repeat service. While in Mbozi 23.3% experienced difficult in detecting heat, few AI technicians and high cost in repeat services (Table VIII).

B. Reasons for Using AI as Breeding Method

About 48.8% of the farmers mentioned that they preferred AI so as to get improve genetic qualities of the progenies, 8.5% said it reduces cost of keeping a bull, 13.4% mentioned improving genetic potential and avoid cost of raising a bull while, 12.2% said it gives healthier calves with good growth rate (Table VII).

D. Constraints in Using AI Service as Breeding Method

Table IX below shows key constraints for AI users. These include inefficient semen supply and few AI technicians (45.1%). The latter was more critical factor in Njombe.
Nonetheless, all respondents in the study areas face some constraints in using natural service as their breeding method. Farmer (33.3%) in Mbozi reported cost of raising a bull as their major constraints, 38.8% of farmers in Njombe said bull are very far while poor conception rate was the most constraint mentioned by farmers in Mbozi districts (48%) (Table X).

C. Comparison on Cost of AI Service against Natural Service in the Study Area

Results in Fig. 5 show that AI service is more expensive breeding method compared to natural system. The cost for AI range between TSH 15 000/= (6 USD) and TSH 40 000/= (17 USD), with majority of the farmers paying TSH 30 000/= (13 USD) per service. On the other hand, natural service was deemed affordable to most of the farmers and the price ranged between TSH 5000/= (2 USD) and TSH 15000/= (6 USD), majority paying TSH 10000/= (4 USD).

VI. USE OF NATURAL SERVICES AS BREEDING METHOD IN THE STUDY AREA

A. Sources of Breeding Bulls/Mating

The common practice of obtaining a bull for breeding in the three districts was through taking a cow to bull (58.2%) while very few farm kept their own bull (18.2%) (Table X). There were differences between districts in the way bulls are sourced. Whereby in Mbeya most of the farmers (36%) keep their own bulls, while 42% of farmers in Njombe lease from a neighboring household while (72%) took cows to a bull. Further the study revealed that many farmers (38.2%) stopped using AI services due to presence of few technicians and unavailability of AI service. In Mbeya district 38.9% of farmers were not aware of the service, while in Mbozi district 56% of respondents stopped use of AI due to high cost (Table X).

B. Perception of Farmers on Bull Uses and Associated Constraints

The results show that negative thing about using a bull mentioned by farmers (38.2%) was inbreeding problem and was highly observed in Mbozi district (60%). About 30.9% of respondents observed poor performance due to low repeating breeding (Table X).

TABLE IX: PROPORTION OF FARMERS’ RESPONSE ON CONSTRAINTS USING AI

| Constraints                      | Mbeya N=25(%) | Njombe N=22(%) | Mbozi N=35(%) | Total N=82(%) |
|----------------------------------|---------------|----------------|---------------|--------------|
| Few AI technicians               | 4(16)         | 3(13.6)        | 5(14.3)       | 12(14.6)     |
| Inadequate education on AI       | 7(28)         | 1(4.5)         | 6(17.1)       | 14(17.1)     |
| Few AI technicians and inadequate education on AI | 2(8) | 4(18.2) | 13(37.1) | 19(23) |
| Inefficient semen supply         | 12(48)        | 14(63.6)       | 11(31.4)      | 37(45.1)     |

TABLE X: PROPORTION OF FARMERS’ RESPONSES TO FACTORS RELATED TO BULL USES

| Variables                        | Mbeya N=36 | Njombe N=49 | Mbozi N=25 | Total N=110 |
|----------------------------------|------------|-------------|------------|-------------|
| Bull source                      |            |             |            |             |
| Own bull                         | 13(36)     | 4(8)        | 3(12)      | 20(18)      |
| Bull comes to farm               | 2(6)       | 21(43)      | 3(12)      | 26(24)      |
| Take cows to bull                | 23(69)     | 22(45)      | 19(76)     | 64(58)      |
| Why stop using AI                |            |             |            |             |
| Not aware of the service         | 14(40)     | 3(6)        | 3(12)      | 20(18)      |
| Repeated services                | 4(11)      | 5(10)       | 2(4)       | 11(10)      |
| Few technicians/services not available | 6(17)     | 30(61)      | 6(24)      | 42(38)      |
| Expensive                        | 12(33)     | 8(16)       | 14(56)     | 35(32)      |
| Negative things about Bull       |            |             |            |             |
| Don’t know                       | 13(36)     | 13(27)      | 8(32)      | 34(31)      |
| Poor genetic potential           | 11(31)     | 21(43)      | 2(8)       | 34(31)      |
| Inbreeding                       | 12(34)     | 15(31)      | 15(60)     | 42(38)      |
| Constraints using bull           |            |             |            |             |
| Good bulls are not available     | 11(33)     | 11(22)      | 5(20)      | 27(25)      |
| Bulls are very far               | 11(31)     | 19(39)      | 2(8)       | 32(29)      |
| Cost to raise a bull             | 12(33)     | 7(14)       | 6(24)      | 25(23)      |
| Poor conception rate             | 3(8.3)     | 12(20)      | 12(48)     | 28(26)      |

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Educating farmers can raise their ability to adopt easily appropriate technology and management skills [8].

**B. Grazing System, Housing and Herd Structures in the Study Area**

Across districts zero grazing system was the most common system. For example, in Mbozi district all farmers were found to use only zero grazing system and only a few used semi zero grazing methods. A similar result was reported by [9] in a study conducted in Morogoro and Dar es Salaam. Under zero grazing it was observed that feeds were fed to animal in their sheds, mostly through cut and carry which in most cases may lead to underfeeding of the animals leading to poor performance.

It was further observed that sheds used by most of the dairy cattle keeper were very poor and poor housing is associated with poor hygiene which expose animal to discomfort as well as creating an environment that is conducive for disease emergence. Often stress related to poor shed design led to decline productivity of the dairy cow [10]. According to [11] standards design for cow sheds should have consideration for adequate space for sleeping, walking, and feeding.

The mean herd size was 5.21±0.29 while cows and heifer mean were 1.89±0.07 and 0.65±0.06 respectively which were higher compared to bulls and bull calves with mean of 0.14±0.03 and 0.49±0.05, respectively. The reason for keeping female’s animal can be for replacement and milk production. The mean head size under smallholder conform to value of 3 to 4 and 4 to 7 under extensive smallholder farms as reported by [4] in Bangladesh. However, the observed mean herd size was a bit lower compared to mean herd size 8.5±6.4 reported by [12] 11.1± 08 reported by [9] in Dar es Salaam. Friesian and Aryshire cross were the dominant breeds, and most farmers keep Friesian crosses breed and few Aryshire crosses.

**C. Dairy Cattle Breeding and Reproduction**

Results showed that majority of farmers mate their animals for the first time when they had attained the age of 18 months and few mate their heifer when they reach the age of 19 to 24 months. Also it was revealed that age and signs of heat were the main factor determine mating. Studies had shown that under good management, heifer could reach maturity at 10 to 12 months and can conceive on first service at the age of 14 to 15 months [13], [14]. However, under tropical conditions 12-40 months has been reported which is by large contributed by poor management [15] thus the observed age at first mating is consistent with other studies in the tropics.

According to Gaines [16] who stated that body conditions and hormones slowly return to their cyclic functional status and animal should come to heat and show signs of heat within 30 to 60 days after calving. In the current study it was further revealed that majority of farmers inseminated their animals 90days after calving which is longer time. However, [17] observed that in some cases longer days from calving to first insemination in smallholder units could be due to infection of cows when they give birth in unhygienic conditions, abnormal delivery for instance dystocia, retained placenta or prolapsed of uterus, provision of in adequate nutritional feeds, late heat detection.

It was also apparent that natural service (NS) was the predominant breeding method across the three districts compared to Artificial insemination. NS and AI services were used singly or in combination to breed cattle. Similar observations were reported in other places such as in Turiani and Bukoba districts in Tanzania [6] and Dar es Salaam and Morogoro in Tanzania [18], [9]. In Kenya [19] observed increased use of AI mainly attributed to availability of AI service. To the contrary low use of AI service in rural areas has been associated with low performance of AI (NSC, FSC), and high cost of AI service similar to observations by [20].

Although artificial insemination has been used in Tanzania for over 50 years, Constraints related to its overall performance had limited its wide uses. In the study sites most of the farmers had been using AI for more than ten years implying that they have adequate experiences. Nonetheless the observed poor conception following use of AI in this study could have resulted from problems other than heat detection. In some cases, this was attributed to use stockmen who are not motivated and skilled enough as cautioned by [21] and [9].

Heat detection and optimal time of insemination are major factors that influence the performance of AI, however, more farmers interviewed under the study check for heat signs once or twice per day in duration of less than ten minutes. Normally they check it in morning or morning and evening time. This frequency and duration taken could be insufficient and can lead to missing of heat signs which will lead to high NSC and low FSC. [22] and [23] recommended that for accuracy detection of heat by visual observation, observation period should be at least three times per day within a duration of thirty minutes. Heat signs known by most interviewees were mucus discharge, nervousness and restless, bellowing licking vulva and few mentioned stands to be mounted and mounting others. From the results it is obvious that most of the farmers had knowledge on secondary signs of heat and very few mentioned “stand to be mounted” which is the primary signs of heat as also reported by [24].

Apart from poor management under small farmers conditions other factors had been reported by other scholars which restrict behavioral manifestations of oestrus signs which were footing surface (slippery ground) pens [25], unhealthy feet [23], milk fever [26]), change in social status within herd [27], and heat stress [28]. [29] Reported environmental factors which inhibit cows to express primary signs and less oestrus behavior such as poor housing with earthen/mud floor, unhygienic condition, cows contained in substandard structure.

Since majority of farmers (> 90%) use zero grazing cows may not be able to show primary signs of heat and thus farmer tend to rely on secondary heat signs which can be misleading. These observations conform to finding by [24], and [30].

[23] argues that skilled farm managers achieve up to 75 % heat detection efficiency. Therefore, better education of dairy stockmen focusing on heat signs detection would result in animals being reported and inseminated at recommended time. Also, to decrease NSC and increase FSC farmers and AI technician should make a follow up to be able to detect easily cows that returned to heat [31].

It was also apparent that most of cows/ heifers were inseminated between 6-10 hours after heat signs were observed in all districts. While other animals were
Inseminated between 1-5 hours and very few were inseminated above 10 hrs after being heat signs were detected. These results confirmed that most of the cows/heifers were inseminated too early rather than the optimal time for insemination which is 12 hours after onset of oestrus [32], [33]. Hence, all animals inseminated below this optimal time were likely to have poor reproductive results. [34] Reported that animals inseminated above 32 hours after detection of heat signs had poor pregnant results. Thus, farmers are advised to have closer contact with AI technician to allow insemination at optimal time. To date this can be facilitated through improvement of mobile communication.

The problem of poor reproductive efficiency which could be also related to poor breeding service record keeping. It was observed that most of the farmers (53.7%) did not keep records related to AI service and Mbeya appeared to have many farmers who did not keep records compared to other districts. Poor dairy recording keeping under smallholder farms is in consistent to observation made by [35] in central Uganda. According to [36] in order to improve heat detection there is a need to use combination of heat detection methods to improve reproductive performance. These may include recording, heat calendar and visual observation.

D. Use of AI and Natural Services as Preferred Breeding Method in the Study Area

Despite the shortfalls of using AI, farmers who reported to use AI the advanced reason is that the method gave quick results in terms of improving genetic potential of their animals. Likewise, use of AI was invariably less costly compared to keeping a bull. It is thus obvious that farmers recognized and appreciated the importance of this simple technology on improvement of reproductive performance [37]. According to [38], AI can quickly improve genetic progress four times faster than the use of NS. AI was also preferred method since it reduces the costs related to bull management thus conform to finding by [39].

Despite the benefit of using AI the main challenges reported by farmer were on oestrus detection and determining the insemination time. Majority of farmers claimed that it was difficult to detect heat and even if heat is detected, availability of qualified AI technician becomes a secondary constraint. Some farmers mentioned high cost of AI in case of repeat service which would increase cost hence, exacerbating the negative perception of farmers on AI service especially when not using calendar.

In generally AI infrastructure in the Southern highland of Tanzania and with I the country is poor which lead to high cost of the service. In this study most farmers from Mbeya and Njombe district mentioned unavailability of semen and few AI technician as the major constraints whereas, in Mbozi few AI technicians and lack of education (Training on AI) were the factors that hinder the effective use of AI.

All AI technicians were self-employed and had other work apart from providing AI services. This means that AI technicians were not fully committed to provision of AI services. It was also observed that the problem become bigger due to poor unavailability of liquid nitrogen (LN2) as well as semen. Some of the technicians had to travel to Dar salaam or NAIC Arusha (More than 900km) to purchase LN2 and semen. Under this situation AI service become unreliable and very cost full which demoralizes farmers to use AI as their main breeding method. Thus, the uses of Natural service become inevitable [40].

AI user complained that the service was very expensive compared to NS. The results conform to those reported by [19] in Kenya which was cost (20 USD) per insemination. However, imported semen in Kenya cost much 125USD [41]. It was also revealed that most farmers took cows/heifers to bulls and very few farmers had their own bull for breeding. Farmers reported that the distance between cow units to breeding bull units was very far and, in some cases, they have to travel up to 4 km. This distance can lead to delayed mating, consequently, resulting to poor conception. Likewise, long trekking may cause stress to cows/heifers which can decrease expression of heat [42]. Due to an availability of fewer good bulls’ farmers keep mating cows to same bull which may increase the rate of inbreeding under small farmer’s condition [43].

Although NS was predominant breeding method under the study area, farmers who were using AI and changed to NS reported that few AI technician, unavailability of service and high cost were the reasons for stopping using AI service. These results suggested that farmer recognized the importance of AI but, constrained by reasons mentioned above. Similar observation was reported by [40]. It becomes apparent that, if AI service becomes reliable and the number of AI technician is increased majority of farmers are likely to use AI service rather than NS. Also inbreeding is accelerated with poor recording of mating and poor supervision of mating program.

VIII. CONCLUSION AND RECOMMENDATION

A. Conclusions

Natural service (NS) is the predominant breeding method used in the southern Highland of Tanzania due to unreliability of AI service.

Time of insemination, poor knowledge of heat detection practices, animal factors, and negative perception on AI service, poor communication, unavailability of LN2, and location factors contribute to un-use of AI service as preferred breeding method under smallholder farmer’s conditions in Tanzania.

B. Recommendations

There is a need to enhance training of smallholder dairy farmers on the importance of proper housing, heat detection, herd management, breeding and nutrition, records keeping improving dairy reproductive efficiency through the use AI service.

All stakeholders should come together to improve animal breeding infrastructure in the country so as to improve animals’ productivity.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest regarding the material discussed in this paper.
REFERENCES

[1] Lopez H, Satter L and Wiltbank M. Relationship between the level of milk production and oestrus behaviour of lactating dairy cows. Animal Reproduction Science. 2004; 81: 209-223.

[2] Njokome AP, Msanga YN, Temba AE and Tixo M. Efforts to increase dairy cattle in Tanzania. Ministry of livestock and fisheries development. Dar es Salaam, Tanzania 2008, site visited 18/12/2021 from http://www.mafugo.go.tz.

[3] Hossain MM, Alam M, Kabir M, Rashid MM, Asaduzzaman M. and Rahman MM. Small scale dairy farming practice in a selected area of Bangladesh. Pakistan Journal of Nutrition, 2005; 4 (4): 215-221.

[4] Uddin MN, Uddin MB, Al Mamun M, Hassan MM and Khan MHH. Small scale dairy farming for livelihoods of rural farmers: Constraints and prospects in Bangladesh. Journal of Animal Science Advances, 2012; 2 (6): 543-550.

[5] Mwambene PL, Katule AM, Chemyangumba SW and Mwakilembe PAA. Fipa cattle in the southwestern highlands of Tanzania: socio-economic roles, traditional management practices and production constraints. Journal of Animal Genetic Resources, (FAO), 2012:51:1–14. DOI: http://dx.doi.org/10.1017/s2078636120000112.

[6] Asimwe L. Factors influencing breeding and reproductive efficiency in smallholder dairy cattle in Tanzania: A case study of Turiani Division and Bukoba district. M.Sc. Thesis Sokoine University of Agriculture Morogoro, Tanzania 2004; 80 pp.

[7] World Bank. Strengthening agricultural extensions and advisory system: Procedures for assessing, transforming and evaluating extension systems. Agriculture and Rural Development, 2010;44:81–85.

[8] Yeakonoge S, Koonwoorrittron S, Elio M and Siwanesope T. Effect of experience, education, record keeping, labour and decision making on monthly milk yield and revenue of farms supported by private organization in Central Thailand. Australasian Journal of Animal Science, 2010; 23(6): 814-824.

[9] Gillik K A, Kifaro GC and Madsen JA description of management and production levels of cross bred dairy cattle in Dar es Salaam and Morogoro urban and peri urban areas. Academia Journal of Agricultural Research, 2013; (18):131-144, visited 10/12/2021 from http://dx.doi.org/10.15413/ajar.2013.0107.

[10] Kassa TM. A study on urban agriculture: the case of small-scale urban dairy farming in selected areas of Addis Ababa, M. A thesis presented to the school of graduate studies of the Addis Ababa University in partial fulfilment of the requirements for the degree of M.A. in Geography 2003:pp.175-177.

[11] FAO. Farm structure in tropical climates: A Textbook for structural engineering and design. Bengtsson, L.P. and Whittaker, J.H. (Editors). FAO/SIDA Cooperative Programme. Rural Structures in East and South-East Africa 1998; pp 167 from http://www.fao.org/docrep/006/SC2050E/00.htm.

[12] Kirvait FA, Noordhuizen JPTM and Kapama AG. Prospects and Constraints of Smallholder Dairy Husbandry in Dar es Salaam Region, Tanzania, Agriculture and Rural Development, 2006; 35(3): 209-215.

[13] Ibrahim MNN and Zemmelnik GA. Comparative evaluation of integrated farm models with the village situation in the Forest-Garden area of Kandy, Sri Lanka. Asian-Australasian Journal of Animal Sciences, 2000; 13(1):53-59.

[14] Hafez ESE, and Hafez B. Reproduction in Farm Animals (7th edition). Lea and Febiger, Philadelphia, USA,2000; $10 pp.

[15] Njarius DMG, Gathere M, Wambua JM, Nguluki S, Mnangi DM and Keya GA. Dairy cattle value chain assessment: Characterisation of milk production in semi-arid Kenya. Working document, Kenya Arid and Semi-arid Land Programme (KASAL) 2009; 77pp.

[16] Gaines JD. Investigating sub fertile dairy herds: three case histories, Veterinary Medicine, 1990:85: 409-517.

[17] Mekonnen T, Bekana M and Abayneh T.Reproductive performance and efficiency of artificial insemination in smallholder dairy calves is assessed in and around Arsi-Negelle, Ethiopia. Livestock Research for Rural Development 2010; from http://www.lrrd.org/lrrd22/3.

[18] Gillah KA, Kifaro GC and Madsen JA. Urban and peri urban dairy farming in East Africa: A review on production levels, constraints and opportunities. Livestock Research for Rural Development, 2012;24:198. http://www.lrrd.org/lrrd24/11/gill24198.htm.

[19] Munguoe EEO, Njarius DMG, Gathere M, Kabiruji R and Ndikumana J. Reproductive and health constraints of dairy cattle in the peri-urban areas of semi-arid eastern Kenya. Livestock Research for Rural Development, 2014; http://www.lrrd.org/lrrd26/6/mung26098.htm.

[20] Msanga YN, Bryant MJ and Katule AM. Effect of environmental factors and performance of Holstein breed on days to first insemination and calving interval of crossbred dairy cattle on smallholder farmers in Northeast Tanzania. In: Proceedings of the Tanzania Society of Animal Production. Arusha, Tanzania. 1999; pp. 161-175.

[21] Salem B, Djemali M, Kayouli C and Majdoub A. A review of environmental and management factors affecting the reproductive performance of Holstein-Friesian dairy herds in Tunisia. Livestock Research for Rural Development, 2006. http://www.lrrd.org/lrrd18/4/ael18035.htm.

[22] Kastelic J. Computerized Estrus Detection Western Canadian Dairy Seminar March 12, WCDS Proceedings 2001. http://www.wcds.affis.alberta.ca/Proceedings/2001/Chapter%2030.pdf.

[23] Nebel RL. Components of a successful heat detection program 2003; Advanced documents storage/Dairy%20/ Sumbawanga%20final.pdf.

[24] Favley L and Chantalakhana C. Smallholder dairy farming in the tropics International Livestock Research Institute, Nairobi, Kenya. 2009; pp. 28pp.

[25] Britt JH, Schott RG, Armstrong JD and Whitacre MD. Determinants of estrous behavior in lactating Holstein cows. Journal of Dairy Science, 1986;69:2195-2202.

[26] Borsberry S and Dobson H. Periparturient diseases and their effect on Reproductive performance in five dairy herds. Veterinary Record, 1989;124:217-219.

[27] Dobson H and Smith RF. What is stress, and how does it affect reproduction. Animal Reproduction Science, 2000;60:743–752.

[28] Wolfenson D, Roth Z and Meidan R. Impaired reproduction in heat stressed cattle: basic and applied aspects. Dairy Animal Reproduction Science, 2000;60:555-547.

[29] Stevenson JS. Reproductive management of dairy cows in high milk-producing herds. Journal of Dairy Science, 2001;84:E128-E143.

[30] Issuja RJ. The influence of artificial insemination on reproductive performance of dairy cows in selected farms. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 2012; pp 60 pp.

[31] Pursley JR. Strategies and rationale for resynchronization of ovulation in lactating dairy cows. In: Proceedings of Dairy Cattle Reproduction Council Annual Meeting, Denver CO, 2007; pp. 37-43.

[32] Looper M. When should the cow be inseminated? College of Agriculture Home and Economics.2000; http://www.thedairysite.com/…/when-should-dairy-cows-be–inseminated.

[33] Dalton JC, Nadir S, Bame JH, Noft singer M, Nebel RL and Saagee RG. Effect of time of insemination on number of accessory sperm, fertilization rate, and embryo quality in non-lactating dairy cattle. Journal of Dairy Science, 2001; 84:2413-2418.

[34] Pursley JR, Silcox RW and Wiltbank MC. Effect of time of artificial insemination on pregnancy rates, calving rates, pregnancy loss, and gender ratio after synchronization of ovulation in lactating dairy cows. Journal of Dairy Science, 1998;81(8): 2139-2144.

[35] Mugisha A, Kayizzi V, Owiny D and Mburu J. Breeding Services and the factors influencing their use on smallholder dairy farms in central Uganda. Veterinary Medicine International, 2014;4:6 pp.

[36] Peralta OA, Pearson RE and Nebel RL. Comparison of three estrus detection systems during summer in a large commercial dairy herd. Animal Reproduction Science, 2005; 87:59-72.

[37] Rodriguez-Martinez H. Assisted reproductive techniques for cattle breeding in developing countries: a critical appraisal of their value and limitations. Reproduction in Domestic Animals, 2012;47:21-26.

[38] Van Vleck LD (eds). Potential genetic impact of artificial insemination, sex selection, embryo transfer, cloning and selfing in dairy cattle. In: Brackett GG, Seidel GE, Siedel SM. New Technologies in Animal Breeding, New York, USA, Academic Press. 1981; pp 221-242.

[39] Mureda E and Zeleke Z. Characteristics and constraints of crossbred dairy cattle production in lowland areas of Eastern Ethiopia. Livestock Research for Rural Development, 2008;20:57. http://www.lrrd.org/lrrd20/4/mure20057.htm.

[40] Msanga BSJ, Bryant MJ, Thome PJ. Some factors affecting variation in milk yield in crossbred dairy cows on smallholder farms in North-east Tanzania. Tropical Animal Health Production, 2005;37: 403-412.

[41] Munuiki HG. Dairy development in Kenya. Food and Agriculture Organization (FAO) Dairy report, 2011;52-60.

[42] Swai ES, Kyakaisho P and Ole-Kawanaa MS. Studies on the reproductive performance of crossbred dairy cows raised on smallholder farms in eastern Usambura Mountains, Tanzania. Livestock Research for Rural Development, 2007;19:61. http://www.lrrd.org/lrrd19/5/swai9601.htm.

[43] Desalegn G and Medhin. Performance of artificial insemination: challenges and opportunities in Ethiopian meat and dairy technology institute workshop on “alternatives for improving feed AI delivery system” [file]Aprua 2011.