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Selection Criteria for Holstein Friesian and Crossbreed Dairy Cattle Objective Traits in Ethiopia

Amare Berhe Kidane[1,2*], Kefena Effa Delesa[3], Yesihak Yusuf Mummed[2], Million Tadesse Tegegn[4]

[1]Samara University, Samara, Ethiopia
[2]Haramaya University, Haramaya, Ethiopia
[3]International Livestock Research Institution (ILRI), Addis Ababa, Ethiopia
[4]Ethiopian Institute of Agricultural Research (EIAR), Holeta, Ethiopia
Email: *kidaneamare@su.edu.et

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Abstract

There was no research regarding selection criteria for the economically relevant dairy cattle objective traits in Ethiopia. Therefore, the goal of this paper was to determine the selection criteria for Holstein Friesian and crossbreed dairy cattle economically relevant traits. The research was based on 236 respondents of large, medium and small scale dairy farms from Dire-Dawa, Harar, Bishoftu, Holeta agricultural research center and Mekele. Data were analyzed using statistical analysis software and traits preferences were ranked by calculating index values with the principle of weighted average. For Holstein Friesian producers, the most preferred breeds were pure Holstein Friesian, Holstein Friesian crossbreeds and local cattle breeds with an overall index value of 0.47, 0.36, and 0.13, respectively. Similarly for crossbreed producers, pure Holstein Friesian (0.46), Holstein Friesian crossbreed (0.37) and local cattle (0.15), respectively, were their main breed preferred. In the present study, both Holstein Friesian and crossbreed producers were used milk yield (0.61, and 0.64) and milk yield composition (0.39, and 0.34), as the main preferred selection criteria for milk composition, respectively. On the other situations, age at first calving (0.45, and 0.39), age at first service (0.38, and 0.37), and service per conception (0.08, and 0.17), were the preferred selection criteria for economically relevant reproduction traits both for Holstein Friesian and crossbreed, respectively.

Keywords

Dairy Cattle, Economically Relevant Traits, Selection Criteria

1. Introduction

Ethiopia is known for its huge livestock population and is estimated to have 59.5 million heads of cattle, 30.6 million sheep, 30.2 million goats, 59.5 million of poultry, 2.16 million horses, 8.43 million donkeys and 1.21 million camels, respectively [1]. Livestock production makes an essential contribution to agriculture, food and rural development. They provide products and services such as milk, meat, draught power and manure for fertilizers and fuel [2]. As compared to its potential and contribution to the Ethiopian economy, the livestock sector is less productive and production per animal is extremely low [3]. Milk production and reproductive traits are crucial factors and they are determinant for the profitability of dairy production [4].

Breeding is aimed at changing the genetic merit of animals in the coming generations such that, they will produce the desired products more efficiently (relative to the present generation) under future economic, natural and social circumstances [5]. Breeding objective is defined as the reason (s) for which animals are specifically bred for, it assumes that the farmers have made a deliberate choice to genetically improve the next generation of animals in terms of their performance in relation to their parent generations [6]. The basic principle of any industry is the generation of efficient and productive results that lead to maximized economic returns [7]. The definition of selection objectives for a combination of economically important traits should be the first step in implementing a breeding program [8] [9] [10]. The selection criteria are the basis for formulating the profit equation, from which the economic values are derived [11]. Selection criteria are those traits that can be measured on the animal and can also be used as predictors of the traits included in the breeding objectives [12]. Traits included in the breeding objectives (*i.e.* economically relevant traits) may be the same or different from the selection criteria. When the objective trait and selection criterion are different, the selection criteria are known as an indicator trait. An indicator trait is a trait that is used to indicate the merit of an animal for another trait [13].

The estimated breeding value of an observed trait can be readily calculated as a linear function of the estimated breeding value for measured trait (s) [14]. Many economically relevant traits in dairy cattle are difficult to measure and therefore need to be predicted by indicator traits. The value of an indicator trait will depend largely on the magnitude of co-heritability and genetic correlation between the objective trait and the indicator trait [15]. In the Ethiopian dairy farms, there is no information on selection criteria for dairy cattle objectives traits. So, the present study was focused on selection criteria of dairy cattle objective traits both for Holstein Friesian and crossbreed dairy cattle breeds.

2. Material and Methods

2.1. Description of the Study Area

The study was conducted at the selected large, medium and small scale dairy

farms at Dire Dawa, Harar, Bishoftu dairy farms and Mekele (**Figure 1**). Moreover, institutional dairy farms at Haramaya University and Holeta agricultural research center were used for the study.

Dire Dawa

Dire Dawa is geographically located in eastern parts of Ethiopia between 9˚27'E and 49'N latitude and between 41˚38'N and 19'E longitude and is located 515 km away from Addis Ababa [16]. Topographically, it is a dissected mountainous region with the mountain ranges located in the southern part. Dire dawa has a bimodal rainfall with the mean annual rainfall varying from 550 mm in the northern lowlands to about 850 mm in the southern mountains. The mean annual maximum and minimum temperatures of the town are 31.4˚C and 18.41˚C, respectively [17]. The total human population of the town is estimated at 288,000 with a growth rate of 2.5% [18].

Harar

The Harari region is one of the nine administrative regions of Ethiopia. Harari National Regional State is located at a distance of 525 km eastern of Addis Ababa [19]. The Harari region lies between latitude 9˚24'N and 9˚42'03"E and 42˚16'E longitude. The Harari region has a wet tropical and receives an annual rainfall between 596 mm and 900 mm in a bimodal pattern. It is located at an altitude of 1850 meters above sea level and has a mean annual maximum and minimum temperature of 25 and 10˚C, respectively [20]. The total human population of the town is estimated at 125,000 with a growth rate of 2.6% [18].

Bishoftu

Bishoftu is a town and separate district located in the East Shewa zone at a distance of 45 km South East of Addis Ababa, Ethiopia. The town is located in east Showa zone of Oromia region and it lies 9˚ North latitude and 40˚ East longitude at an altitude of 1850 meters above sea level in the central high land of Ethiopia. It has an annual rainfall of 866 mm of which 84% is in the long rainy season (June to September) and the remaining in the short rainy season extending from March to May. The mean annual maximum and minimum temperatures of the area are 26˚C and 14˚C, respectively, with mean relative humidity of 61.3% [21].

Holota

Holota is a town and separate district in the Oromia special zone surrounding Finfinnee. The town is located 40 km west of Addis Ababa at 9˚30'N and 38˚30'E with altitude range from 2300 - 3800 meters above sea level. The annual mean temperature ranges from 14˚C to 24˚C and annual rainfall ranges from 900 - 1100 mm. According to the population and housing censes of 2007 the population of the town is 23,296 (male = 11,512, female = 11,784). (49.41% male and 50.59% female) [18].

Mekele

Mekelle, the regional capital city of the Tigray region, commonly known as Semenawit Kokob to mean the star of north is one of the largest cities in Ethiopia which is located in the northern Ethiopia high lands at 777 km drive north

of national capital city, Addis Ababa. Geographically, the city is situated between 13˚29'N 39˚28'E latitude and 13.48˚N 39.47˚E longitude. It has an average altitude of 2084 meters above sea level with a mean minimum, mean maximum and mean average monthly temperatures of 8.7˚C, 26.8˚C and 17.6˚C, respectively [22]. Mekelle has an estimated total population of 215,546 [23].

2.2. Sampling Strategy and Data Collection

The study was conducted at large, medium and small scale dairy farms of Diredawa, Harar, Bishoftu, Hollota agricultural research center and Mekele dairy farms. Dairy cattle producers were classified on the basis of the number of dairy cows they owned and level of input for their dairy farms. Before the actual work was started, focused group discussions were held with the different experts working at the regional and zonal agricultural development office. Discussions were also made with dairy cattle owners. The total number of households interviewed on the dairy production system was 236 respondents. Semi-structured

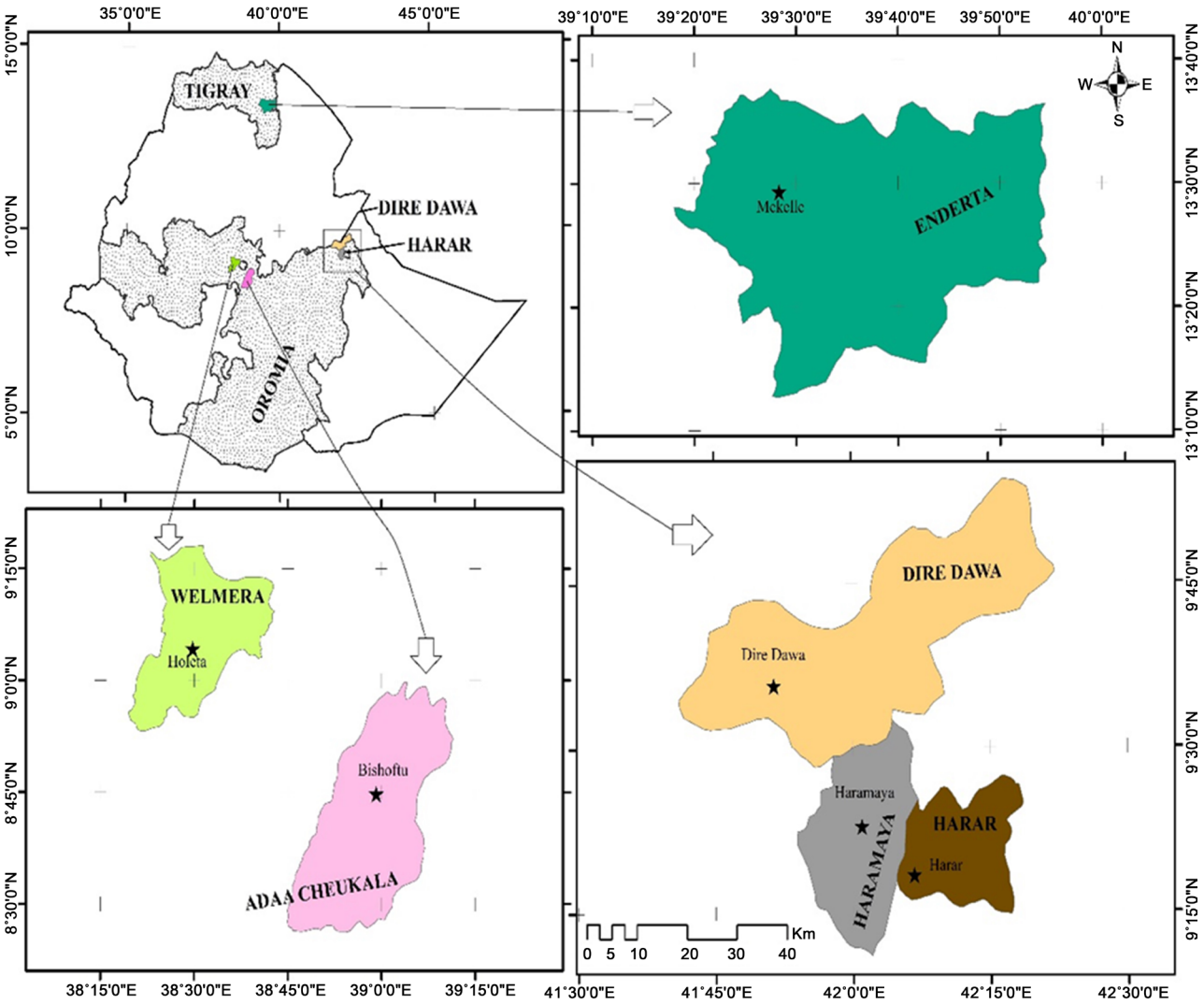

Figure 1. Map of study area.

questionnaire and formal interviews were used to collect information from the selected households. The questionnaire was tested before the actual survey to ensure that all questions were sufficiently clear for the interviewees. Data on the genera breed preferences, culling criteria and selection criteria for economically relevant traits were collected by trained enumerators.

2.3. Data Analysis

Statistical analysis software [24] was used to describe the general household characteristics across all the production systems. Preference ranking was ranked by calculating index values with the principle of weighted average according to the following formula.

$$\text{Index} = \left(R_n \times C_1 + R_{n-1} \times C_2 + \cdots + R_1 \times C_n\right) \Big/ \sum \left(R_n \times C_1 + R_{n-1} \times C_2 + \cdots + R_1 \times C_n\right)$$

where, R_n = the last rank. C_n = the % of respondents in the last rank, C_1 = the % of respondents ranked first

3. Results and Discussions

3.1. Dairy Cattle Breed Preferences

Breed preferences for Holstein Friesian and crossbreed dairy cattle producers are presented in Table 1 and Table 2. For the large scale Holstein Friesian dairy producers, pure Holstein Friesian, Holstein Friesian crossbreed and Jersey crossbreed dairy cattle were the main breed preferred with an index value of 0.45, 0.38 and 0.06, respectively. On the other hand for the medium and small scale dairy producers, pure Holstein Friesian, Holstein Friesian crossbreed and local dairy cattle breeds were the main breed preferences with a mean index value of 0.47, 0.48, 0.36, 0.35 and 0.17, 0.17, for medium and small scale, respectively. Similar to the medium and small scale Holstein Friesian dairy cattle producers, pure Holstein Friesian (0.49, 0.45 and 0.44), Holstein Friesian crossbreed (0.34,

Table 1. Ranking of breed preferences for Holstein Friesian dairy cattle producers.

Breeds	Holstein Friesian dairy cattle producers												Overall index
	Large scale				Medium scale				Small scale				
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	
Pure Holstein Frisian	75.00 (15)	20.00 (4)	5.00 (1)	0.45	82.50 (33)	17.50 (7)	0.00	0.47	90.00 (27)	10.00 (3)	0.00	0.48	0.47
Pure jersey	0.00	5.00 (1)	30.00 (6)	0.02	0.00	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.01
Holstein Friesian crossbreed	25.00 (5)	75.00 (15)	0.00	0.38	17.50 (7)	82.50 (33)	0.00	0.36	10.00 (3)	90.00 (27)	0.00	0.35	0.36
Jersey crossbred	0.00	0.00	35.00 (7)	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Local breeds	0.00	0.00	30.00 (6)	0.05	0.00	0.00	100.00 (20)	0.17	0.00	0.00	100.00 (20)	0.17	0.13

Note: R1 = rank 1, R2 = rank 2, R3 = rank 3, I = index.

Table 2. Ranking of breed preferences for crossbreed dairy cattle producers.

Breeds	Crossbreed dairy cattle producers												Overall index
	Large scale				Medium scale				Small scale				
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	
Pure Holstein Frisian	95.00 (19)	5.00 (1)	0.00	0.49	68.89 (31)	31.11 (14)	0.00	0.45	61.73 (50)	38.27 (31)	0.00	0.44	0.46
Holstein Friesian crossbred	5.00 (1)	95.00 (19)	0.00	0.34	31.11 (14)	68.89 (31)	0.00	0.38	38.27 (31)	61.73 (50)	0.00	0.40	0.37
Jersey crossbred	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.74 (33)	0.06	0.02
Local breeds	0.00	0.00	100.00 (20)	0.17	0.00	0.00	100.00 (20)	0.17	0.00	0.00	59.26 (48)	0.10	0.15

Note: R1 = rank 1, R2 = rank 2, R3 = rank 3, I = index.

0.38 and 0.40) and local breeds (0.17, 0.17, and 0.10) were the main breed preferred for large medium and small scale crossbreed dairy producers, respectively. The results revealed that majority of the respondents in the study with area were greatly attached with pure Holstein Friesian and Holstein Friesian crossbreed dairy cows. This was found to be in line with their objectives of dairy farming, which milk production was as source of income generation. Unlike to the current study farms, farms in the Jimma town, Ethiopia would prefer to crossbreed cows with high milk production, high fertility and longs lactation length [25].

3.2. Reasons for Preferring Holstein Friesian and Crossbreed Dairy Cattle

Under the Ethiopian dairy production system where milk is sold on volume basis, high milk yield is the most important criteria for selecting a specific dairy cattle breed. The reasons for preferring Holstein Friesian and crossbreed dairy cattle are present in **Table 3** and **Table 4**. For the Holstein Friesian dairy producers, high milk yield (0.41, 0.43 and 0.46), high reproductive efficiency (0.24, 0.33 and 0.25) and fast growth rate (0.22, 0.25, and 0.23) were the most preferred traits for large, medium and small scale dairy farms, respectively. Unlike the Holstein Friesian dairy producers, high milk yield (0.44 and 0.43), fast growth rate (0.39 and higher reproductive efficiency (0.23 and 0.20) were the most preferred traits for the large and small scale crossbreed dairy producer, respectively. on the other hand, similar to the large scale Holstein friesian producers, high milk yield, high reproductive efficiency and fast growth rate were the main preferring traits for crossbreed dairy cattle in the medium scale crossbreed dairy producers with an index value of 0.43, 0.33 and 0.23, respectively. the current study showed that the reasons for preferring crossbreed dairy producers was different from [25] who reported that milk yield (0.26), fertility (0.23), lactation length (0.22) and longevity (0.14) were the main reasons for ranking crossbreed cows in the small holder dairy farms of Jimma town, Ethiopia.

Table 3. Reasons for preferring Holstein Friesian breeds.

Traits	Holstein Friesian dairy cattle owners											
	Large scale				Medium scale				Small scale			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
HMY	70.00 (14)	25.00 (5)	5.00 (1)	0.41	55.00 (22)	45.00 (18)	0.00	0.43	76.67 (23)	20.0 (6)	3.33 (1)	0.46
LBS	0.00	0.00	5.00 (1)	0.01	0.00	0.00	0.00	0.00	0.00	6.67 (2)	6.67 (2)	0.03
HFCE	5.00 (1)	5.00 (5)	10.00 (2)	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HRE	20.00 (4)	25.00 (5)	45.00 (9)	0.24	30.00 (12)	37.50 (15)	32.50 (13)	0.33	23.33 (7)	23.33 (7)	33.33 (10)	0.25
HDR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FGR	5.00 (1)	45.00 (9)	40.00 (8)	0.22	15.00 (6)	17.50 (7)	67.50 (27)	0.25	0.00	43.33 (13)	53.33 (16)	0.23
DF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tem	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67 (2)	3.33 (1)	0.03

Note: R1 = rank 1, R2 = rank 2, R3 = rank 3, I = index, HMY = high milk yield, LBS = large body size, HFCE = high feed conversion efficiency, BY = butter yield, HRE = high reproductive efficiency, HDR = high disease resistance, FGR = fast growth rate, DF = dairy form/type, GL = good longevity, Tem = good temperament.

Table 4. Reasons for preferring crossbreeds.

Breeds	Crossbreed dairy cattle owner											
	Large scale				Medium scale				Small scale			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
HMY	70.00 (14)	25.00 (5)	5.00 (1)	0.44	60.0 (27)	40.0 (18)	0.00	0.43	80.25 (65)	16.05 (13)	3.70 (3)	0.46
LBS	0.00	10.00 (2)	10.00 (2)	0.05	0.00	0.00	0.00	0.00	0.00	1.23 (1)	8.64 (7)	0.02
HFCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HRE	30.00 (6)	10.00 (2)	30.00 (6)	0.23	24.44 (11)	51.11 (23)	24.44 (11)	0.33	14.81 (12)	22.22 (18)	33.33 (27)	0.20
HDR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FGR	45.00 (9)	50.00 (10)	0.00	0.39	15.56 (7)	8.89 (4)	75.56 (34)	0.23	4.94 (4)	48.15 (39)	45.68 (37)	0.26
DF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23 (1)	0.00
GL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tem	10.00 (2)	5.00 (1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.11 (9)	8.64 (7)	0.05

Note: R1 = rank 1, R2 = rank 2, R3 = rank 3, I = index, HMY = high milk yield, LBS = large body size, HFCE = high feed conversion efficiency, BY = butter yield, HRE = high reproductive efficiency, HDR = high disease resistance, FGR = fast growth rate, DF = dairy form/type, GL = good longevity, Tem = good temperament.

3.3. Culling Criteria of Holstein Friesian and Crossbreed Dairy Cows

Culling is one of the most complicated decisions that dairy producers make on an almost day-to-day basis. Culling is the act of removing animals from a livestock production enterprise. The culling criteria for Holstein Friesian and cros-

sbreed dairy cows are presented in Table 5 and Table 6. In the study areas, respondents were practiced both voluntary and involuntary culling. For the Holstein Friesian dairy cattle producers, health problem, old age, late calving interval and late age at first services were the main criteria for culling dairy cows. In the large Holstein Friesian dairy producers, respondents cull their animals based on health problems, old age, late calving interval and late age at first services with an index value of 0.36, 0.26, 0.25, and 0.14, respectively. For the medium scale producers, dairy cows were culled based on health problem, ate age at first services and late calving interval with an average index value of 0.48, 0.33 and 0.21, respectively. Unlike to the large and medium scale dairy producers, old age, late calving interval, health problem and difficulty in birth were the main culling criteria for small scale dairy cow producers with an average index value of 0.50, 0.29, 0.26, and 0.21, respectively.

Similarly, for crossbreed dairy cattle producers, health problem, old age, late calving interval and late age at first services were the main culling criteria. For the large scale crossbreed dairy cows, health problem (0.45), late age at first services

Table 5. Culling criteria for Holstein Friesian dairy cattle.

Traits	Production system												Overall index
	Large scale				Medium scale				Small scale				
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index	
Age	5.00 (1)	50.00 (10)	40.00 (8)	0.26	0.00	0.00	0.00	0.00	100.00 (30)	0.00	0.00	0.50	0.25
LMY	0.00	0.00	0.00	0.00	10.00 (4)	0.00	7.50 (3)	0.06	0.00	0.00	0.00	0.00	0.02
LAFS	0.00	35.00 (7)	15.00 (3)	0.14	0.00	100.00 (40)	0.00	0.33	0.00	0.00	0.00	0.00	0.16
HP	65.00 (13)	5.00 (1)	5.00 (1)	0.35	92.50 (37)	0.00	7.50 (3)	0.48	26.67 (8)	0.00	73.33 (22)	0.26	0.36
DB	0.00	0.00	5.00 (1)	0.01	0.00	0.00	0.00	0.00	0.00	26.67 (8)	73.33 (22)	0.21	0.07
LCI	30.00 (6)	10.00 (2)	40.00 (8)	0.25	7.50 (3)	10.00 (4)	82.50 (33)	0.21	0.00	73.33 (22)	26.67 (8)	0.29	0.25

Note: age = old age, LMY = low milk yield, LAFS = late age at first service, HP = health problem, DB = difficulty in birth, LCI = late calving interval.

Table 6. Culling criteria for crossbreed dairy cattle.

Traits	Production system												Overall index
	Large scale				Medium scale				Small scale				
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index	
Age	0.00	0.00	0.00	0.00	53.33 (24)	46.67 (21)	0.00	0.42	86.42 (70)	13.58 (11)	0.00	0.48	0.30
LMY	20.00 (4)	0.00	15.00 (3)	0.13	0.00	0.00	42.22 (19)	0.07	0.00	0.00	0.00	0.00	0.07
LAFS	0.00	100.00 (20)	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
HP	85.00 (17)	0.00	15.00 (3)	0.45	46.67 (21)	53.33 (24)	0.00	0.41	27.16 (22)	0.00	38.27 (31)	0.20	0.35
DB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.04 (30)	41.98 (34)	0.19	0.06
LCI	15.00 (3)	20.00 (4)	65.00 (13)	0.25	0.00	0.00	57.78 (26)	0.1	0.00	49.38 (40)	48.15 (39)	0.24	0.20

Note: age = old age, LMY = low milk yield, LAFS = late age at first service, HP = health problem, DB = difficulty in birth, LCI = late calving interval.

(0.33), late calving interval (0.25), and low milk yield (0.13) were the main preferred culling criteria. Unlike to the large scale, old age, health problem and low milk yield were the preferred culling criteria for medium scale dairy cows with an average index value of 0.42, 0.41 and 0.07, respectively. For the small scale crossbreed producers, old age, late calving interval, health problem, and difficulty in birth were the main culling criteria with an average index value of 0.48, 0.24, 0.20, and 0.19, respectively. Unlike to the present study, dairy producers in the Alefa and Quara districts of North Gonder zone, Amhara regional state, Ethiopia, were culled their dairy cow based on long age at first service, long calving interval and high number of service per conception with an overall index value of 0.34, 0.23, and 0.20, respectively [26].

3.4. Means of Acquiring Dairy Cattle Breeds

The source of foundation for both Holstein Friesian and crossbreed dairy cows are presented in Table 7. For Holstein Friesian dairy cattle, the sources of establishment herd for most households were purchased, gift from their family, born from their own farm, and from project with an overall percentage value of 43.81, 26.58, 17.77 and 11.9, respectively, whereas for the crossbreed dairy cows the sources of establishment of herds were purchase, followed by developed from AI services, born from own farm, gifted from family and from project with an overall percentage value of 49.95, 21.88, 15.06, 11.44, and 1.67, respectively (Table 7).

3.5. Selection Criteria for Holstein Friesian and Crossbreed Dairy Cattle Objective Traits

The selection criteria both for Holstein Friesian and crossbreed dairy cattle objective traits are presented in Table 8 and Table 9. Identifying and determining selection criteria is a prerequisite for developing a breeding objective. Selection criteria are those traits that can be measured on the animals and can be used as predictors of the traits included in the breeding objectives (Hazel, 1943) [12].

3.5.1. Milk Composition

The selection criteria for milk composition both for Holstein Friesian and crossbreed dairy producers are presented in Table 8 and Table 9. For the Holstein Friesian producers, the selection criteria for milk composition were milk yield

Table 7. Means of acquiring Holstein Friesian and crossbreed dairy cattle (%).

Means of acquiring	Holstein Friesian				Crossbreed			
	Large scale	Medium scale	Small scale	Overall	Large scale	Medium scale	Small scale	Overall
Purchase	32.50 (13)	64.71 (55)	34.23 (38)	43.81	50.00 (20)	49.41 (42)	50.45 (56)	49.95
From project	15.00 (6)	15.29 (13)	5.41 (2)	11.9	5.00 (2)	0.00	0.00	1.67
Born own farm	22.50 (9)	0.00	30.63 (34)	17.71	10.00 (4)	11.76 (10)	23.42 (26)	15.06
Gifted from family	30.00 (12)	20.00 (17)	29.73 (33)	26.58	12.50 (5)	4.71 (4)	17.12 (19)	11.44
From AI services	0.00	0.00	0.00	0.00	22.50 (9)	34.12 (29)	9.01 (10)	21.88

and milk color with an overall index value of 0.61 and 0.39, respectively. Similar to the Holstein Friesian dairy cattle producers, the selection criteria for milk composition for crossbreed dairy cattle producers, were milk yield and milk color with an overall index value of 0.64 and 0.36, respectively. In most countries, genetic evaluation of dairy cattle for milk production traits is carried out using test day models [27]. Furthermore, unlike the current study, test day yields of protein, butterfat and lactose are the routinely recorded on milk recorded herds in South African Holstein Friesian and Jersey breeds and therefore are readily available used for as selection criteria [28]. On the other hand, milk colour can also be measured by visual assessment or reflectance colorimetry [29] and milk flavour can be determined by sensory tests which can be considered as selection criteria for milk composition [30].

3.5.2. Reproductive Traits

The selection criteria for reproductive traits both for Holstein Friesian and crossbreed dairy cows are presented in **Table 8** and **Table 9**. Reproductive performance has a significant approach to costs related to herd replacement and insemination [31]. In the large and medium scale Holstein Friesian dairy cattle producers, the preferred selection criteria for reproductive traits were age at first calving (0.42, 0.43), age at first services (0.40, 0.40), and service per conception (0.13, 0.12), respectively. Unlike to the large and medium scale, the most preferred selection criteria for small scale Holstein Friesian producers were age at first calving, age at first service and lactation length with an index value of 0.50, 0.33 and 0.17, respectively. Similar to Holstein Friesian producers, age at first calving, age at first service and service per conception were the most preferred selection criteria for reproductive traits in the crossbreed dairy cattle producers. In the large scale crossbreed dairy cattle producers, age at first service, age at first calving and service per conception were the most preferred selection criteria for reproductive traits with an index value were 0.43, 0.40 and 0.09, respectively whereas for medium scale crossbreed dairy cattle producers, age at first calving, service per conception and age at first service were the main selection criteria practiced with a mean index value of 0.45, 0.38 and 0.17, respectively. Unlike to the medium scale crossbreed dairy cattle producers, age at first service, age at first calving and age at first puberty were the main selection criteria for reproductive traits for small scale crossbreed dairy cattle producers with an index value of, 0.50, 0.33 and 0.17, respectively. Comparing to the Ethiopian dairy cattle producers, calving ease was considered the main selection criterial for reproductive traits [32]. Unlike the present study, calving interval was considered as selection criteria for the economically relevant traits of reproductive traits for South African Holstein Friesian and Jersey cattle [28].

3.5.3. Longevity Traits

The selection criteria for longevity traits both for Holstein Friesian and crossbreed dairy cow are present in **Table 5** and **Table 6**. In the study sites, the se-

lection criteria for longevity traits were herd life, number of lactations, and length of productive lifetime and type traits. In the large and small scale Holstein Friesian dairy cattle producers, herd life (0.44, 0.50), Length of productive lifetime (0.39, 0.33) and number of lactations (0.17, 0.17) were the main selection criteria for longevity traits, respectively. Unlike to the large and small scale Holstein Friesian dairy cattle producers, length of productive lifetime, herd life and type traits were the three main selection criteria for medium scale producers with an average index value of 0.42, 0.37, and 0.13, respectively. Similarly, for the crossbreed respondents, number of lactations, length of productive lifetime and herd life were the main selection criteria for large scale crossbreed dairy producers with an average index value of 0.41, 0.37 and 0.13, respectively. Similarly for medium scale crossbreed producers, number of lactation (0.39), herd life (0.32), and length of productive lifetime (0.29), respectively, were the main preferred selection criteria for the economically relevant longevity traits. Whereas for small scale crossbreed dairy producers, length of productive lifetime, herd life and number of lactations were the preferred selection criteria with an average index value of 0.44, 0.39, and 0.17, respectively. Unlike the Ethiopian dairy farms, different countries used a range of selection criteria, models and analytical procedures to predict longevity traits [33]. In the present study even though inclusion of longevity was good progress it needs to be extended to the other major dairy cattle farms as an indispensable task.

3.5.4. Cow Comfort

Cow comfort is important in maintaining high production and increasing reproductive success in dairy cows. In the present study farms, the selection criteria for the economically relevant traits of cow comfort wad not widely recorded in medium and small scale both for Holstein Friesian and crossbreed dairy farms. In the large scale Holstein Friesian dairy farms, the selection criteria for cow comfort was, type traits, disease incidence, and somatic cell count with an average index value of 0.43, 0.40 and 0.17, respectively. Similarly, for the large scale crossbreed dairy producers, type traits, disease incidence and somatic cell counts were the main selection criteria for cow comfort with an index value of 0.48, 0.35, and 0.17, respectively. According to [34], though there was seldom practices of disease recording in most animal recording schemes, incidence of metabolic diseases (e.g. lameness, ketosis, udder oedema, metritis, milk fever and displaced abomasums) were used as a selection criteria to predict economically relevant cow comfort traits. Other studies stated that, dairy form has also been reported to influence involuntary culling, through its relationship with incidence of metabolic diseases [35].

3.5.5. Udder Health

Economic performances of farm animals can be losses by diseases, through reduced milk yield, reduced productive life time of animas, reduced genetic gain, and reduced milk quality [36]. The preferred selection criteria for udder health

traits are present in Table 8 and Table 9. In the study farms, the main selection criteria for udder health traits were incidence of mastitis, somatic cell count and milking speed. In the large scale dairy farms, incidence of mastitis, milking speed and somatic cell count, were the preferred selection criteria for udder health with an average index value of 0.50, 0.33, and 0.17, respectively. Similarly for medium scale dairy farms, incidence of mastitis, milking speed and somatic cell count were the main selection criteria with an index value of 0.48, 0.36, and 0.17, respectively. Unlike to the large and medium scale dairy producers, incidence of mastitis (100%) was the only means of selection criteria for udder health in small scale Holstein Friesian dairy producers. Similar to the Holstein Friesian dairy farms, incidence of mastitis (0.43 and 0.43), milking speed (0.40 and 0.20), and somatic cell count (0.17 and 0.37) were the most preferred selection criteria for large and medium scale crossbreed dairy producers. Similar to the small scale Holstein Friesian producers, incidence of mastics (100%) were the only preferred selection criteria for small scale crossbreed dairy producers. Similar to the current study farms, majority of the Scandinavian countries well-established and undertake routine genetic evaluation for mastitis incidence [37]. According to [38] report, milking speed has a relationship with udder health, with faster milking cows having higher rates of udder infection. Incorporating information on milking speed in breeding program has genetic predictions for udder health traits [39].

3.5.6. Cow Health

Ethiopia had not established selection criteria for dairy cattle objectives traits. However, dairy cattle producers used some indicator traits as economically relevant for cow health traits. The selection criteria for the economically relevant traits of cow health both for Holstein Friesian and crossbreed dairy cattle are present in Table 5 and Table 6. In the large scale Holstein Friesian dairy farms, disease incidence, milk yield and type traits were the main selection criteria for cow health with an index value of 0.43, 0.29 and 0.28, respectively. Unlike to the large scale, milk yield (0.42, 0.44), disease incidence (0.38, 0.33), and type traits (0.20, 0.23), were the most preferred selection criteria for medium and small scale Holstein Friesian dairy producers, respectively. Similarly for large scale crossbreed dairy farms, disease incidence (0.43), milk yield (0.35), and type traits (0.22), were the three preferred selection criteria for cow health, respectively. Whereas for medium and small scale crossbreed producers, milk yield (0.42, 0.40), disease incidence (0.37, 0.38), and type traits (0.21, 0.22), were the most preferred selection criteria for the economically relevant traits of cow health, respectively. according to [40] report, Scandinavian countries have a subsidized and legally-enforced system for recording disease incidence in dairy cattle selection based on such predictions can yield significant genetic progress in disease resistance.

3.5.7. Feed Cost

Feed is the most important input requirement for dairy production. In the

Table 8. Selection criteria for Holstein Friesian dairy cattle objective traits.

Traits	Production system												Overall index
	Large scale				Medium scale				Small scale				
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index	
Milk composition													
MY	80.00 (16)	20.00 (4)	-	0.60	90.00 (36)	10.00 (4)	-	0.63	80.00 (24)	20.00 (6)	-	0.60	0.61
MYC	20.00 (4)	80.00 (16)	-	0.40	10.00 (4)	90.00 (36)	-	0.37	20.00 (6)	60.00 (24)	-	0.40	0.39
Reproductive traits													
HPR	0.00	5.00 (1)	5.00 (1)	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
AFP	0.00	0.00	15.00 (3)	0.03	0.00	0.00	30.00 (12)	0.05	0.00	0.00	0.00	0.00	0.03
LL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00 (30)	0.17	0.06
AFS	40.00 (8)	60.00 (12)	0.00	0.40	40.00 (16)	60.00 (24)	0.00	0.40	0.00	100.00 (30)	0.00	0.33	0.38
SPC	0.00	5.00 (1)	70.00 (14)	0.13	0.00	0.00	70.00 (28)	0.12	0.00	0.00	0.00	0.00	0.08
AFC	60.00 (12)	30.00 (6)	10.00 (2)	0.42	60.00 (24)	40.00 (16)	0.00	0.43	100.00 (30)	0.00	0.00	0.50	0.45
Longevity traits													
HL	65.00 (13)	35.00 (7)	0.00	0.44	0.00	22.50 (9)	0.00	0.08	100.00 (30)	0.00	0.00	0.50	0.34
NL	0.00	0.00	100.00 (20)	0.17	22.50 (9)	77.50 (31)	0.00	0.37	0.00	0.00	100.00 (30)	0.17	0.24
LPLT	35.00 (7)	65.00 (13)	0.00	0.39	77.50 (31)	0.00	22.50 (9)	0.42	0.00	100.00 (30)	0.00	0.33	0.38
TT	0.00	0.00	0.00	0.00	0.00	0.00	77.50 (31)	0.13	0.00	0.00	0.00	0.00	0.04
Cow comfort													
DI	40.00 (8)	60.00 (12)	0.00	0.40	-	-	-	-	-	-	-	-	
SCC	0.00	0.00	100.00 (20	0.17	-	-	-	-	-	-	-	-	
TT	60.00 (12)	40.00 (8)	0.00	0.43	-	-	-	-	-	-	-	-	
Udder health													
IM	100.00 (20)	0.00	0.00	0.50	80.00 (32)	20.00 (8)	0.00	0.47	100.00 (30)	-	-	1.00	
SCC	0.00	0.00	100.00 (20)	0.17	0.00	0.00	100.00 (40)	0.17	-	-	-	-	
MS	0.00	100.00 (20)	0.00	0.33	20.00 (8)	80.00 (32)	0.00	0.36	-	-	-	-	

Continued

Cow health												
DI	55.00 (11)	45.00 (9)	0.00	0.43	40.00 (16)	50.00 (20)	10.00 (4)	0.38	20.00 (6)	60.00 (18)	20.00 (6)	0.33
TT	20.00 (4)	30.00 (6)	50.00 (10)	0.28	5.00 (2)	12.50 (5)	82.50 (33)	0.20	6.67 (2)	23.33 (7)	70.00 (21)	0.23
MY	25.00 (5)	25.00 (5)	50.00 (10)	0.29	57.50 (23)	35.00 (14)	7.50 (3)	0.42	73.33 (22)	16.67 (5)	10.00 (3)	0.44
Feed cost												
Body weight	60.00 (12)	40.00 (8)	-	0.53	-	-	-		-	-	-	-
Feed intake	40.00 (8)	60.00 (12)	-	0.47	-	-	-		-	-	-	-

Note: MY = milk yield, MYC = milk yield composition, HPR = heifers pregnancy rate, AFP = age at first puberty, LL = lactation length, AFS = age at first service, SPC = service per conception, AFC = age at first calving, HL = herd life, NL = number of lactations, LPLT = length of productive life time, TT = type traits, DI = disease incidence, SCC = somatic cell count, IM = incidence of mastitis, MS = milking speed.

Table 9. Selection criteria for crossbreed dairy cattle objective traits.

Traits	Production system												Overall index
	Large scale				Medium scale				Small scale				
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index	
Milk composition													
MY	90.00 (18)	10.00 (2)	0.00	0.63	95.56 (43)	4.44 (2)	0.00	0.65	91.36 (74)	8.64 (7)	0.00	0.64	0.64
MYC	10.00 (2)	90.00 (18)	0.00	0.37	4.44 (2)	95.56 (43)	0.00	0.35	8.64 (7)	91.36 (74)	0.00	0.36	0.36
Reproductive traits													
AFP	0.00	0.00	45.00 (9)	0.08	0.00	0.00	0.00	0.00	0.00	0.00	100.00 (81)	0.17	0.08
AFS	60.00 (12)	40.00 (8)	0.00	0.43	0.00	0.00	100.00 (45)	0.17	100.00 (81)	0.00	0.00	0.50	0.37
SPC	0.00	0.00	55.00 (11)	0.09	26.67 (12)	73.33 (33)	0.00	0.38	0.00	0.00	0.00	0.00	0.17
AFC	40.00 (8)	60.00 (12)	0.00	0.40	73.33 (33)	26.67 (12)	0.00	0.45	0.00	100.00 (81)	0.00	0.33	0.39
Longevity traits													
HL	0.00	35.00 (7)	10.00 (2)	0.13	46.67 (21)	0.00	53.33 (24)	0.32	34.57 (28)	65.43 (53)	0.00	0.39	0.28
NL	45.00 (9)	55.00 (11)	0.00	0.41	35.56 (16)	64.44 (29)	0.00	0.39	0.00	0.00	100.00 (81)	0.17	0.32
LPLT	55.00 (11)	10.00 (2)	35.00 (7)	0.37	17.78 (8)	35.56 (16)	46.67 (21)	0.29	65.43 (53)	34.57 (28)	0.00	0.44	0.37
TT	0.00	0.00	55.00 (11)	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03

Continued

Cow comfort												
DI	10.00 (2)	90.00 (18)	0.00	0.35	-	-	-		-	-	-	-
SCC	0.00	0.00	100.00 (20)	0.17	-	-	-		-	-	-	-
TT	90.00 (18)	10.00 (2)	0.00	0.48	-	-	-		-	-	-	-
Udder health												
IM	60.00 (12)	40.00 (8)	0.00	0.43	71.11 (32)	17.78 (8)	11.11 (5)	0.43	100.00 (81)	-	-	1.00
SCC	0.00	0.00	100.00 (20)	0.17	20.00 (9)	80.00 (36)	0.00	0.37	0.00	-	-	0.00
MS	40.00 (8)	60.00 (12)	0.00	0.40	8.89 (4)	6.67 (3)	84.44 (38)	0.20	-	-	-	-
Cow health												
DI	60.00 (12)	35.00 (7)	5.00 (1)	0.43	28.89 (13)	64.44 (29)	6.67 (3)	0.37	53.09 (43)	23.46 (19)	23.46 (19)	0.38
TT	15.00 (3)	0.00	85.00 (17)	0.22	4.44 (2)	17.78 (8)	77.78 (35)	0.21	0.00	30.86 (25)	69.14 (56)	0.22
MY	25.00 (5)	65.00 (13)	10.00 (2)	0.35	66.67 (30)	17.78 (8)	15.65 (7)	0.42	46.91 (38)	45.68 (37)	7.41 (6)	0.40
Feed cost												
Body weight	70.00 (14)	30.00 (6)	-	0.57	-	-	-		-	-	-	-
Feed intake	30.00 (6)	70.00 (14)	-	0.43	-	-	-		-	-	-	-

Note: MY = milk yield, MYC = milk yield composition, AFP = age at first puberty, LL = lactation length, AFS = age at first service, SPC = service per conception, AFC = age at first calving, HL = herd life, NL = number of lactations, LPLT = length of productive life time, TT = type traits, DI = disease incidence, SCC = somatic cell count, IM = incidence of mastitis, MS = milking speed.

present study, both medium and small scale Holstein Friesian and crossbreed dairy farms, didn't have any criteria for predicting the economically relevant trait of feed for their dairy cows. Whereas in the large scale Holstein Friesian and crossbreed dairy cattle producers, body weight (0.57, 0.53), and feed intake (0.43, 0.43), were the most preferred selection criteria for the economically relevant traits feed cost, respectively. Unlike the current study, body weight, milk urea nitrogen, stature, rump length and width, body depth and feed intake are most practiced selection criteria for the economical trait of feed cost for South African Holstein Friesian and Jersey cattle breeds [27]. So, Integrating multi-traits is important to improve the genetic merit for efficiency of feed utilization.

4. Conclusions and Recommendations

The present study focuses on the selection criteria of dairy cattle objective traits. The contribution of the livestock sector to the Ethiopian economy is manifold. It

provide the needed animal protein in the form of products like meat, milk, eggs and cheese contributing to nutritional security; provide power for cultivation, threshing, and transport; confer a certain degree of security during periods of crop failure; provide farmyard manure to improve soil fertility and also as a source of energy; and other economic and social benefits. In the present study, dairy farm producers did not had standardized criteria for their dairy cattle objective traits particularly in the medium and small scale farms both for Holstein Friesian and crossbreed producers they did not fix any criteria for cow comfort, feed cost and udder health (in small scale dairy farms) dairy cattle objective traits. So, to improve the existing dairy cattle production potential giving equal opportunities for all dairy cattle objective traits and setting selection criteria for each of the dairy cow trait is an indispensable task.

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Conflict of Interests

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Questionnaire

1. General information

1.1. Name of respondent_____ age_____

Region_____ zone_____

Gender_____

1.2. Position in household (tick one)

A. household head_____ B. spouse head_____

C. relative_____ D. son_____

E. daughter_____ F. other (specify)_____

1.3. Marital status (tick one)

A. Married_____ B. Divorced_____ C. Widowed_____

D. Unmarried_____ E. Other (specify)_____

2. Household characteristics

A. How many children between age 10 and 18 years are in this household? ___

B. How many children less than 10 years old are in this household? _____

C. How many children above 18 years old are in this household? _____

D. Total number of children in this household? _____

E. How many dairy laborers are in this household? _____

F. How many permanent workers in this household? _____

3. Land owner and its allocation for farm activities

A. Do you own/rent/squatter/gifted land (tick one)?

- ❖ Own_____
- ❖ Rent_____
- ❖ Squatter_____
- ❖ Gifted from family_____

B. How many hectare of land do you have?_____

C. How many plots of land do own?_____

- ❖ Amount of land used to cultivate for crop (in hectare)_____
- ❖Amount of land used to cultivate for improve forage (in hectare)_____
- ❖ Amount of land used to grazing land (in hectare)_____
- ❖ Amount of land used for conserved hay production(in hectare) _____
- ❖ Types of improved forage crops cultivated? (Tick)

Oat _____ Vetch_____ Elephant grass_____

Legume trees _____ Others (specify) _____

4. Herd structure of household

A. What type of cattle breed (s) do you have? (Tick and number)

- ❖ Pure exotic only_____
- ❖ Crossbreed only_____
- ❖ Local only_____
- ❖ Both pure exotic and crossbreed_____

- ❖ Both crossbreed and local_____
- ❖ Both pure exotic and local_____
- ❖ All_____

B. What other livestock species do you have? (Tick and number)

- ❖ Horses_____
- ❖ Donkey_____
- ❖ Mule_____
- ❖ Chicken_____
- ❖ Sheep_____
- ❖ Goats_____
- ❖ Honey bee_____
- ❖ Camel_____

C. How many pure exotic cattle do you have?_____ (Tick and number)

- ❖ Milking cows_____
- ❖ Dry cows_____
- ❖ Oxen_____
- ❖ Heifers greater than one year pregnant_____
- ❖ Heifers greater than one year non-pregnant_____
- ❖ Calves less than one year_____

D. Which exotic cattle breed do you have? (Tick and number)

- ❖ Holstein Friesian_____
- ❖ Jersey_____
- ❖ I do not know_____
- ❖ Others (specify)_____

E. How many crossbreed cattle do you have? (Tick and number)

- ❖ Milking cows_____
- ❖ Dry cows_____
- ❖ Oxen_____
- ❖ Heifers greater than one year pregnant_____
- ❖ Heifers greater than one year non-pregnant_____
- ❖ Calves less than one year_____

F. Do you know the type of crossbreed animal you owned? Yes / no. if yes which crossbreed type?

- ❖ Holstein Friesian crossbreed_____
- ❖ Jersey crossbreed_____
- ❖ Others (specify)_____

G. How many local cattle do you have?

- ❖ Milking cows_____
- ❖ Dry cows_____
- ❖ Oxen_____
- ❖ Heifers greater than one year pregnant_____
- ❖ Heifers greater than one year non-pregnant_____
- ❖ Calves less than one year_____

H. How do you first acquire pure exotic dairy cattle? Tick.

- ❖ Purchase_____
- ❖ From project_____
- ❖ Born from own farm_____
- ❖ Inherited from family_____
- ❖ Others (specify)_____

I. How do you first acquire crossbred dairy cattle? Tick.

- ❖ Purchase_____
- ❖ From project_____
- ❖ Born from own farm_____
- ❖ Inherited from family_____
- ❖ Others (specify)_____

J. How do you first acquire local dairy cattle? Tick.

- ❖ Purchase_____
- ❖ From project_____
- ❖ Born from own farm_____
- ❖ Inherited from family_____
- ❖ Others (specify)_____

5. Breed preferences for pure exotic, crossbreed and local dairy cattle

A. Which breed do prefer first **(breed rank first)**.

- ❖ Pure Holstein Friesian_____
- ❖ Pure jersey breed_____
- ❖ Holstein Friesian crosses_____
- ❖ Jersey crosses_____
- ❖ Local breeds_____

B. What are the reasons to rank first (multiple choice is possible)? **Tick**.

- ❖ High milk production_____
- ❖ Large body size_____
- ❖ High feed conversion efficiency_____
- ❖ Butter yield_____
- ❖ High reproductive efficiency_____
- ❖ High disease resistance_____
- ❖ Fast growth rate_____
- ❖ Dairy type_____
- ❖ Good longevity_____
- ❖ Temperament_____
- ❖ I do not know_____
- ❖ Others (specify)_____

C. Which breed do prefer second **(breed rank second)**.

- ❖ Pure Holstein Friesian_____
- ❖ Pure jersey breed_____
- ❖ Holstein Friesian crosses_____
- ❖ Jersey crosses_____

- ❖ Local breeds_____

D. What are the reasons to rank second (multiple choices are possible)? **Tick**.
   - ❖ High milk production_____
   - ❖ Large body size_____
   - ❖ High feed conversion efficiency_____
   - ❖ Butter yield_____
   - ❖ High reproductive efficiency_____
   - ❖ High disease resistance_____
   - ❖ Fast growth rate_____
   - ❖ Dairy type_____
   - ❖ Good longevity_____
   - ❖ Temperament_____
   - ❖ I do not know_____
   - ❖ Others (specify)_____

E. Which breed do prefer third **(breed rank third)**.
   - ❖ Pure Holstein Friesian_____
   - ❖ Pure jersey breed_____
   - ❖ Holstein Friesian crosses_____
   - ❖ Jersey crosses_____
   - ❖ Local breeds_____

F. What are the reasons to rank third (multiple choice is possible)? **Tick**.
   - ❖ High milk production_____
   - ❖ Large body size_____
   - ❖ High feed conversion efficiency_____
   - ❖ Butter yield_____
   - ❖ High reproductive efficiency_____
   - ❖ High disease resistance_____
   - ❖ Fast growth rate_____
   - ❖ Dairy type_____
   - ❖ Good longevity_____
   - ❖ Temperament_____
   - ❖ I do not know_____
   - ❖ Others (specify)_____

6. Breed choice for crossbreeding

A. Which breed type do you prefer to crossbreed your cows? **Tick one**.
   - ❖ Holstein Friesian_____
   - ❖ Jersey_____
   - ❖ Crossbreed_____
   - ❖ I do not know_____
   - ❖ Chosen by inseminators_____
   - ❖ Others (specify)_____

B. If you prefer to use Holstein Friesian sire, explain why? **Multiple choices possible**.

- ❖ For high milk production_____
- ❖ Large body size_____
- ❖ Butter yield_____
- ❖ Temperament_____
- ❖ Feed conversion efficiency_____
- ❖ Better reproductive efficiency_____
- ❖ Fast growth rate_____
- ❖ Easy to breed_____
- ❖ Disease resistance_____
- ❖ Udder conformation_____
- ❖ I do not know_____
- ❖ Other (specify)_____

C. If you prefer to crossbreed your cows with Holstein Friesian sir, what level of exotic inheritance do you prefer? Tick.

- ❖ 25%_____
- ❖ 37.5%_____
- ❖ 50%_____
- ❖ 75%_____
- ❖ >75%_____
- ❖ I do not know_____
- ❖ Other (specify)_____

D. If you prefer to use jersey sire, explain why? **Multiple choices possible**.

- ❖ For high milk production_____
- ❖ Large body size_____
- ❖ Butter yield_____
- ❖ Temperament_____
- ❖ Feed conversion efficiency_____
- ❖ Better reproductive efficiency_____
- ❖ Fast growth rate_____
- ❖ Easy to breed_____
- ❖ Disease resistance_____
- ❖ Udder conformation_____
- ❖ I do not know_____
- ❖ Other (specify)_____

E. If you prefer to crossbreed your cows with jersey sir, what level of exotic inheritance do you prefer? Tick

- ❖ 25%_____
- ❖ 37.5%_____
- ❖ 50%_____
- ❖ 75%_____
- ❖ >75%_____
- ❖ I do not know_____
- ❖ Other (specify)_____

7. Reproductive efficiency

A. For pure Holstein Friesian dairy cattle
- ❖ Estimate age at first calving (**in days/months**)_____
- ❖ Estimate age at first service (**in days/months**)_____
- ❖ Estimate day open (from calving to the next insemination/service) (**in months**)_____
- ❖ Estimate number of lactations completed(**months/ days)**_____

B. For Holstein Friesian cross local dairy cattle
- ❖ Estimate age at first calving (**in days/months**)_____
- ❖ Estimate age at first service (**in days/months**)_____
- ❖ Estimate day open(from calving to the next insemination/service) (**in months**)_____
- ❖ Estimate number of lactations completed(**months/ days**)_____

C. For pure jersey dairy cattle
- ❖ Estimate age at first calving (**in days/months**)_____
- ❖ Estimate age at first service (**in days/months**)_____
- ❖ Estimate day open(from calving to the next insemination/service) (**in months**)_____
- ❖ Estimate number of lactations completed(**months/ days**)_____
- ❖ For jersey cross local dairy cows
- ❖ Estimate age at first calving (**in days/months**)_____
- ❖ Estimate age at first service (**in days/months**)_____
- ❖ Estimate day open(from calving to the next insemination/service) (**in months**)_____
- ❖ Estimate number of lactations completed(**months/ days**)_____

D. For local dairy cows
- ❖ Estimate age at first calving (**in days/months**)_____
- ❖ Estimate age at first service (**in days/months**)_____
- ❖ Estimate day open(from calving to the next insemination/service) (**in months**)_____
- ❖ Estimate number of lactations completed(**months/ days**)_____

8. Milk production

A. For Holstein Friesian dairy cattle if any
- ❖ What is the average daily milk yield in liters from calving to the first three months (early lactation stage) **(in liters)**?_____
- ❖ What is the average daily milk yield in liters during mid-lactation (from 3 - 6 months) **(in liters)?**_____
- ❖ What is the average daily milk yield in liters during late lactation (from 6 months onwards) **(in liters)?**_____

B. For pure jersey dairy cattle if any
- ❖ What is the average daily milk yield in liters from calving to the first three months (early lactation stage) **(in liters)**?_____
- ❖ What is the average daily milk yield in liters during mid lactation (from 3 - 6 months) **(in liters)?**_____

- ❖ What is the average daily milk yield in liters during late lactation (from 6 months onwards) **(in liters)?**_____

C. For Holstein Friesian cross local dairy cattle

- ❖ What is the average daily milk yield in liters from calving to the first three months (early lactation stage) **(in liters)**?_____
- ❖ What is the average daily milk yield in liters during mid lactation (from 3 - 6 months) **(in liters)?**_____
- ❖ What is the average daily milk yield in liters during late lactation (from 6 months onwards) **(in liters)?**_____

D. For jersey cross local dairy cattle if any

- ❖ What is the average daily milk yield in liters from calving to the first three months (early lactation stage) **(in liters)**?_____
- ❖ What is the average daily milk yield in liters during mid lactation (from 3 - 6 months) **(in liters)?**_____
- ❖ What is the average daily milk yield in liters during late lactation (from 6 months onwards) **(in liters)?**_____

9. Major farming activates practiced by the household

A. What is the major farming activity/ practiced? **Tick box**

- ❖ Livestock production only_____
- ❖ Crop production only_____
- ❖ Both_____

B. What is the main purpose of keeping pure exotic cattle?

- ❖ Only for milk production_____
- ❖ To produce replacement heifers_____
- ❖ To produce replacement draught oxen_____
- ❖ Mainly to produce replacement draught oxen followed by milk_____
- ❖ Indicators of wealth status in the community_____
- ❖ Others (specify)_____

C. What is the main purpose of keeping crossbreed cattle?

- ❖ Only for milk production_____
- ❖ Mainly to produce milk followed by replacement heifers_____
- ❖ Mainly to produce milk followed by draught oxen_____
- ❖ Mainly to produce replacement draught oxen followed by milk_____
- ❖ Indicators of wealth status in the community_____
- ❖ Others (specify)_____

D. What is the main purpose of keeping local cattle?

- ❖ Only for milk production_____
- ❖ Mainly to produce milk followed by replacement heifers_____
- ❖ Mainly to produce milk followed by draught oxen_____
- ❖ Mainly to produce replacement draught oxen followed by milk_____
- ❖ Indicators of wealth status in the community_____
- ❖ Others (specify)_____

10. Dairy cattle trait preferences

A. Which of the dairy traits/conformation your prefer most in your dairy farm?

- Milk traits
  - Milk persistency_____
  - Age at first calving_____
  - Lactation length_____
  - Fat yield_____
  - Butter yield_____

11. Input costs and output costs

A. Breeding costs

- What is your preferred breeding method?
  - Artificial insemination(AI)_____
  - Bull service/natural mating_____

B. If your preference is artificial insemination, who provide the service?

- Government_____
- Private AI services_____
- Both_____

C. If the service is given by government, what is cost per insemination (ETB)_____

D. If the service is given private AI service, what is cost per insemination (ETB)_____

E. If the service is by bull service what is cost per bull service(ETB)_____

12. Feed costs

A. Do you use concentrate? yes/no (tick one)

- If yes, price per quintal in ETB in2014?_____
- If yes, price per quintal in ETB in2015?_____
- If yes, price per quintal in ETB in2016?_____
- If yes, price per quintal in ETB in2017?_____

B. Do you buy hay? Yes/no (**tick one**)

- What is the unit?
  - Bell_____
  - Heap_____
  - Land size(convert to hectare)_____
- What is the price per unit per the unit selected above in 2014?_____
- What is the price per unit per the unit selected above in 2015?_____
- What is the price per unit per the unit selected above in 2016?_____
- What is the price per unit per the unit selected above in 2017?_____

13. What is the source of costs for your dairy farm?

_____

_____

_____

_____

_____

14. What is the source of income for your dairy farm?

_____

_____

_____

_____

_____

15. What is your breeding goal?

_____

_____

_____

_____

_____

16. How do you define your goal/profit in your production system? (Rank)

A. Profit per unit of gazing land_____

B. Profit per unit of animal_____

C. Profit per unit of feed_____

D. Others_____

17. What are the traits which have more emphasis/ stress on your production systems? (Rank)

A. Production traits _____

B. Reproduction traits_____

C. Type traits/ conformation traits_____

D. Secondary traits (longevity, udder health, temperament, milking speed) _____

18. What type of production traits evaluated in your production system? (Rank)

A. Milk yield_____

B. Fat yield_____

C. Protein yield_____

19. What type of type/conformation traits evaluated in production systems? (Rank)

A. Angularity/ dairy form_____

B. Chest depth_____

C. Rump width_____

D. Rear leg set_____

E. Udder depth_____

F. Teat length_____

G. Rear teat placement_____

H. Front teat placement_____
I. Fore udder attachment_____
J. Rear udder height_____

20. What are the criteria to cull your dairy cattle in your production system? (Rank)

A. Age_____
B. Low milk yield_____
C. Late age at first service_____
D. Poor body structure_____
E. Health problem_____
F. Difficulty in birth_____

21. What is your selection goal in your production system?

_____
_____
_____
_____

22. What are the economically traits for milk composition? (Rank)

A. Milk yield_____
B. Protein yield_____
C. Fat yield_____
D. Somatic cell count_____

23. What are the economically traits for reproduction traits? (Rank)

A. Number of insemination_____
B. Days in milk_____
C. Calving ease_____
D. Replacement rate adjusted for milk yield_____
E. Rate of stillbirths_____

24. What are the economically traits for longevity? (Rank)

A. Health cost_____
B. Replacement rate_____
C. Milking time_____

25. What are the economically traits for udder health? (Rank)

A. Replacement rate_____
B. Milk quality_____
C. Milk yield_____
D. Mastitis treatment cost_____

26. What are the economically traits for cow comfort? (Rank)

A. Longevity_____

B. Bacterial count_____
C. Treatment cost_____
D. Milk yield_____

27. What are the economically traits for milk ability? (Rank)

A. Residual feed intake_____
B. Expected cow maintenance_____

28. What are the economically traits for your livestock environment? (Rank)

A. Environmental cost_____
B. Resistance to parasites_____

29. What are the economically traits for feed costs? (Rank)

A. Expected feed maintenance_____
B. Residual feed intake_____
C. Nitrogen balance_____

30. What are the selection criteria for the reproduction group traits in your dairy farm? (Rank)

A. Heifer pregnancy rate_____
B. Age at puberty_____
C. Lactation length_____
D. Age at first calving_____
E. Services/conception_____
F. Calving interva_____
G. Days open_____
H. Days to first service_____
I. Body condition score_____
J. Milk progesterone_____
K. Milk urea nitrogen_____
L. Calving ease score_____
M. Birth weight_____
N. Gestation length_____
O. Stillbirth_____
P. Pelvic measurements_____
Q. Rump angle_____
R. Rump width_____

31. What are the selection criteria for the longevity group traits in your dairy farm? (Rank)

A. Herd life_____
B. Number of lactations_____
C. Stayability_____
D. Length of productive life_____
E. Survival rate_____
F. Type traits_____

32. What are the selection criteria for the cow comfort group traits in your dairy farm? (Rank)

A. Disease incidence_____
B. Somatic cell count (SCC) _____
C. Bovine Lymphocyte_____
D. Antigens (BoLA)_____
E. Immune response to antigen injection_____
F. Serum lysozyme activity_____
G. Serum haemolytic complement_____
H. Efficiency of phagocytosis_____
I. Calcium mobilization_____
J. Plasma concentration of glucose, ketones, insulin, thyroxine_____
K. Tick count_____
L. Faecal egg count_____
M. Molecular markers_____
N. Type traits_____

33. What are the selection criteria for the udder health group traits in your dairy farm? (Rank)

A. Incidence of mastitis_____
B. Test day Somatic Cell_____
C. Score (SCS)_____
D. Milking speed_____
E. Udder type traits_____
F. Electrical conductivity_____
G. Lactose concentration_____
H. Bovine serum albumin concentration_____
I. Concentration of chloride_____
J. sodium or potassium_____
K. Markers of immune response_____

34. What are the selection criteria for the milk ability group traits in your dairy farm? (Rank)

A. Milking speed scores_____
B. Kilograms milk per minute_____
C. Temperament scores_____
D. Approachability to humans_____
E. Flight distance from humans_____
F. Flinch, step & kick behavior_____
G. Linear type scores_____
H. Residual milk_____
I. Heart rate_____

35. What are the selection criteria for the environmental cleanliness group

traits in your dairy farm? (Rank)

A. Milk Urea Nitrogen_____

B. Nutrient balance_____

C. Methane/greenhouse gases_____

D. Tick counts_____

E. Faecal egg counts_____