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Selection of Indigenous Goat Types for Designing Product Specific Breeding Strategy in Selected Districts of West Amhara, Ethiopia

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Abstract: Ethiopia has 28,163,332 goat populations with 11 phenotypically and 8 in genotypically distinct goat breeds. Even though the country as well as the region has large size of goat population, the productivity per unit of animal is relatively low. Therefore, the objective of this research was to identify the indigenous goat types for designing product specific breeding strategy. The study was conducted in three goat potential districts of different agro-ecology. For the study, ranks and body measurements for economically important traits identification were employed. The results of this study revealed that goats are ranked as the first important livestock species in Ebnat and Gonji kolela districts and the second in Farta district cattle. The results of selection of goat types based on quantitative traits also shown that average body length (BL) for dairy, dual and meat type goats were 59.65±0.58, 54.87±0.69 and 55.52±0.74cm, respectively. Dairy type goats have significantly higher ($p<0.05$) average pelvic width (15.05±0.20 cm) than dual (13.09±0.24 cm) and meat (12.70±0.25 cm) type goats. Selection of goat types based on dairy specific traits revealed that average rear udder diameter (RUD) for dairy, dual and meat type female goats were 10.04±0.22, 8.66±0.37 and 8.01±0.30 cm, respectively. Rear udder length (RUL), udder circumference (UCC) and teat length (TTL) in these breeds averaged were 17.14±0.28, 31.39±0.59 and 3.71±0.07cm, 14.21±0.48, 26.75±1.01 and 3.41±0.12cm and 13.44±0.38, 24.67±0.81 and 3.01±0.09 cm, respectively. In conclusion, there were significant differences among indigenous dairy type, dual and meat type goats in almost all traits. However, farmers did not use product specific specialized production system and thus, technological intervention is crucial to alleviate the identified constraints and improve product specific indigenous goat development.

Key words: Agro-ecology · Goat types · Selection · Traits

INTRODUCTION

The livestock population of Ethiopia is currently estimated to be 55,027,280 cattle, 27,347,933 sheep, 28,163,332 goats, 6,953,077 donkeys, 1,963,010 horses, 356,087 mules and 1,098,312 camels excluding nomadic areas and is diverse genetically. Goats greater than two years accounts about 51.32%; among this 44.73%, 3.48% and 2.64% are used for breeding, milk production and meat production, respectively [1]. Indigenous goats of Ethiopia are resistant to diseases and parasites have good flocking instinct, ability to walk long distances in search of feed, highly tolerant to adverse climatic conditions with high endurance to droughts and to low and fluctuating nutrient availability [2]. In addition to this, goat milk provides more nutritional and therapeutic value than dairy cow's milk [3] and dairy goats require less land than dairy cows [4]. In this case keeping dairy goats as a more affordable and appropriate option for milk production [5].

The country has 11 phenotypically [6] and 8 in genotypically distinct goat breeds [7]. In Ethiopia alone, there were 28,163,332 goats. Out of these total goats, 70.98 % are females and about 29.02 % are males. The number of female goats kept for milk at country level is estimated to be about 980 thousand, which is 3.48 % of the total goats [1]. Amhara National Regional State also has six goat ecotypes i.e. Gumuz, Awi, Central Abergelle, Abergelle, Begiamedir and Bati [8]. The region is endowed with 5,291,571 goats; particularly the South Gonder zone and Western Gojam have 434,230 and 315,142 goats, respectively [1]. Milk production from goat in this region is insignificant. Moreover most farmers in the region do not want to utilize the milk from goats.

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Even though the country as well as the region has large size of goat population, the productivity per unit of animal especially milk production and the contribution of this sector for both the national and the regional economy is relatively low. This mainly due to poor nutrition, disease prevalence, lack of appropriate breed and breeding strategies and poor understanding of the production system as a whole [9]. Because of less productivity, local goat breeds were subjected to replacement and crossbreeding with imported goat breeds like Anglo-Nubian, Saanen and Toggenberg introduced at different periods by different organizations. However, indiscriminate crossbreeding of indigenous goats can cause genetic erosion, loss of genetic diversity and reduction of adaptive value for efficient utilization of the existing adapted goat genetic resources [8]. Therefore, the objective of this research was to select the indigenous goat types for designing product specific breeding strategies with respect to dairy, meat and dual purpose in goat population potential in the selected districts of north-western Amhara, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area: The study was conducted in Ebnat, Farta and Gonji kolela districts of Amhara region in 2014 (Figure 1). These districts were purposively selected based on agro-ecology, goat population potentials and experience of using goat milk. Ebnat district considered as lowland, Gonji kolela as midland and Farta as highland.

Ebnat district is located in the South Gondar administrative zone. It is located 122 km from Bahir Dar, the capital of the Amhara region and 714 km away from Addis Ababa. Annual temperature and rainfall is ranges 25°C to 30°C and 500-900mm. The district has a total livestock population of 562,040; from this 131,505 are indigenous goats. The district's major socio- economic problem is food insecurity [10].

Farta district is situated at 11°40' N latitude and 38° E longitude (Abebaw Nega and Solomon Melaku, 2009) and located at about 97 km north-east of Bahir Dar, capital city of the Amhara Region and 667 km away from Addis Ababa, capital of Ethiopia. It lies within an altitude range of 1920-4135 m a.s.l. The district receives an average annual rain fall of 900-1099 mm and a mean-range temperature of 9-25°C. The district has a total livestock population of 432,822 from this 40,193 are indigenous goats. The district's major socio- economic problem is food insecurity [11].

Gonji kolela is located south of Bahir Dar in the West Gojjam Zone, with an altitude of 2216 meters above sea level, annual average temperature 21°C and annual average rainfall 1338mm. It is situated 70-km southwest of Bahir Dar. The district has a total livestock population of 260,685; from this 52,350 are indigenous goats [12].

Data Collection Methods: From Gonji kolela and Farta district, three peasant/kebele administrations (PA) were purposively selected based on goat population where as from Ebnat district five PA were selected based on goat population as well as agro ecology of PA. Qualitative traits were documented using a semi-structured questionnaire along with visual appraisal of the appearance of the goat types for phenotypic characterization. For quantitative trait district 87 goats from Ebnat, district 79 goats from Farta and from Gonji kolela district 69 goats were measured. A total of 235 dairy

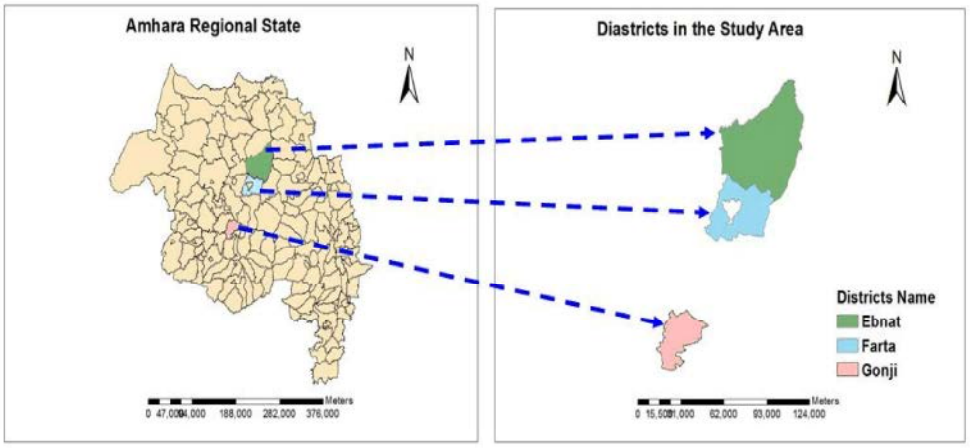

Fig.1: 1Map of the study areas

(109), dual (50) and meat (76) type goats were considered. About twelve morphological quantitative characters (EL- Ear length, BL- Body length, NL- Neck length, DBL- Diagonal body length, HG- Heart girth, HW- Height at wither, PW- Pelvic width, PH- Pelvic height, RW-Rump width, RL- Rump length, TL- Tail length and TW- Tail width) were measured. Reproductive traits such as RUD- Rear udder diameter, RUL- Rear udder length, UCC- Udder circumference, TTL-Teat length, SL- Scrotum length, SW- Scrotum width and SCC-Scrotum circumference were also measured.

Data Analysis: The data collected for identification were managed, coded and fed to MS-Excel (2007). The qualitative data were analyzed for each district. General Linear Model (GLM) of multivariate analysis of SAS 9.1.3 was used to quantify fixed effects such as the goat type, agro-ecology and sex. Pair wise comparison was employed when it was significant to reveal the difference between means. The model used for GLM analysis was:-

$$Y_{ijkl} = \mu + A_i + S_j + D_k + B_l + e_{ijkl}$$

where

Y_{ijk} Is the observed measurement
μ Is the overall mean;
A_i Is the effect of i th age group;
S_j Is the effect of j th sex (male and female);
D_k Is the effect of kth district or agro-ecology;
B_l Is the effect of lth breed (dairy type goat, dual purpose goat and meat type goat); and
e_{ijkl} Is the random residual error.

RESULTS AND DISCUSSION

Livestock Species and Their Importance: Goats were ranked as the first important livestock species in Ebnat and Gonji kolela districts followed by cattle. However, in Farta district cattle were ranked as first followed by goats and sheep (Table 1). The possible reasons reported for goats were the first important livestock species were they are resistant to diseases and parasites, ability to walk long distances in search of feed, high tolerance to adverse climatic conditions and endurance to droughts.

Selection of Goat Types Based on Quantitative Traits: Average body length (BL) for dairy, dual and meat type goats were 59.65±0.58, 54.87±0.69 and 55.52±0.74cm, respectively. Average neck lengths (NL) in these breeds were 32.26±0.37, 29.62±0.43 and 29.01±0.46, respectively (Table 2). There were significantly higher ($p<0.05$) values of average body length and neck length for dairy type goats than dual and meat type goats. Body length of dairy type goats was lower than Alpine and Saanen goats which have 74.33±3.93cm and 74.28±4.78cm, respectively [13]. About 25-36 months and above female Beetal goats have 69.31 ±1.85 cm body lengths in Peshawar, Pakistan which was also higher than the present study [14]. Neck length of the present dairy goats was higher than Beetal goats in Pakistan which have 30.8 cm neck length. Average diagonal body length (DBL) for dairy, dual and meat type goats were 64.52±0.62, 59.93±0.73 and 61.22±0.78, respectively. Average heart girth (HG) in these breeds was 79.27±0.69, 75.44±0.81 and 75.31±0.87 cm, respectively. There were significantly higher ($p<0.05$) values of average diagonal body length and heart girth for dairy type goats than dual and meat type goats. Heart girth of the present dairy goats was lower than Beetal goats in Pakistan which have 82.0±3.49 cm heart girth [15]. Heart girth of Jamnapari female goats in India was 76.1±0.38 cm, which was lower than the result of dairy type goats [16]. About 25-36 months and above Beetal goats have 74.89±0.93 cm heart girth which was lower than the present dairy type goats [14].

Table 1: Livestock species according to their importance

Species	Rank 1st	Rank 2nd	Rank 3rd	Rank 4th	Index
Ebnat					
Cattle	15.4	58.3	16.7	8.3	0.27
Sheep	0	16.7	50.0	16.7	0.16
Goats	76.9	25.0	0	0	0.40
Chickens	0	0	33.3	25.0	0.09
Donkeys	7.7	0	0	50.0	0.08
Farta					
Cattle	69.2	23.1	8.3	0	0.37
Sheep	0	15.4	50.0	0	0.14
Goats	30.8	61.5	8.3	0	0.33
Chickens	0	0	8.3	45.5	0.06
Donkeys	0	0	25.0	36.4	0.08
Mules	0	0	0	9.1	0.01
Horses	0	0	0	9.1	0.01
Gonji kolela					
Cattle	21.1	73.7	5.3	0	0.32
Sheep	5.3	0	15.8	43.8	0.09
Goats	73.7	15.8	5.3	6.3	0.37
Chickens	0	5.3	26.3	37.5	0.10
Donkeys	0	5.3	47.4	12.5	0.12

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular species of livestock divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for species

Table 2: LSM±SE Ear length, body length, neck length, diagonal body length, heart girth and height at wither for goat type and district

	EL	BL	NL	DBL	HG	HW
Effect and Level	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Grand	13.89±0.10	57.08±0.42	30.58±0.26	62.23±0.43	77.04±0.47	70.80±0.41
Goat type	***	***	***	***	***	**
Dairy	14.30±0.14^{a}	59.65±0.58^{a}	32.26±0.37^{a}	64.52±0.62^{a}	79.27±0.69^{a}	72.16±0.61^{a}
Dual	13.64±0.17^{b}	54.87±0.69^{b}	29.62±0.43^{b}	59.93±0.73^{b}	75.44±0.81^{b}	69.05±0.72^{b}
Meat	13.53±0.18^{b}	55.52±0.74^{b}	29.01±0.46^{b}	61.22±0.78^{b}	75.31±0.87^{b}	70.66±0.77^{ab}
District	***	**	***	**	NS	NS
Ebnat	13.42±0.12^{a}	57.45±0.53^{ab}	31.08±0.34^{a}	60.92±0.56^{a}	76.08±0.60	70.69±0.53
Farta	14.42±0.13^{b}	56.51±0.56^{a}	29.86±0.35^{b}	63.50±0.58^{b}	77.80±0.63	70.80±0.60
Gonji kolela	Nm	58.99±0.60^{b}	31.98±0.38^{a}	61.39±0.63^{a}	75.84±0.68	70.81±0.60

EL= Ear length, BL= body length, NL=Neck length, DBL=Diagonal body length, HG=Heart girth and WH= wither height. *Means with the same letter within the same column are not significant.* * Significant at 0.05level= p≤0.05, ** significant at 0.01 level = p≤0.01 and *** significant at 0.001 level = P≤0.001; LSM=least square mean, Nm= not measured, NS=not significant and SE= Standard error.

Table 3: LSM±SE Pelvic width, pelvic height, rump width, rump length, tail length and tail width for goat type, district, age and sex

	PW	PH	RW	RL	TL	TW
Effects and Level	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Grand	13.82±0.15	72.26±0.36	18.27±0.14	15.88±0.12	15.82±0.14	4.08±0.05
Goat type	***	*	***	***	**	***
Dairy	15.05±0.20^{a}	73.37±0.54^{a}	19.31±0.19^{a}	16.61±0.16^{a}	16.29±0.21^{a}	4.40±0.07^{a}
Dual	13.09±0.24^{b}	71.42±0.64^{b}	17.61±0.23^{b}	15.29±0.19^{b}	15.61±0.24^{b}	3.82±0.09^{b}
Meat	12.70±0.25^{b}	71.44±0.68^{b}	17.35±0.25^{b}	15.37±0.21^{b}	15.32±0.26^{b}	3.89±0.09^{b}
District	*	**	NS	***	NS	***
Ebnat	13.69±0.20^{a}	72.68±0.46^{a}	18.24±0.21	15.39±0.16^{a}	15.64±0.19	4.32±0.07^{a}
Farta	13.88±0.21^{a}	71.68±0.49^{a}	18.20±0.22	16.36±0.17^{b}	16.03±0.20	3.83±0.07^{b}
Gonji kolela	14.47±0.23^{ab}	74.07±0.52^{b}	18.35±0.24	16.33±0.18^{b}	Nm	Nm
Age group	***	***	***	***	**	***
1PPI	11.24±0.33^{a}	66.90±0.83^{a}	15.93±0.30^{a}	14.25±0.27^{a}	14.80±0.36^{a}	3.42±0.12^{a}
2PPI	13.24±0.26^{b}	71.47±0.65^{b}	17.60±0.24^{b}	15.49±0.22^{b}	15.50±0.28^{ab}	3.87±0.10^{b}
3PPI	14.18±0.28^{c}	73.91±0.69^{c}	18.45±0.25^{c}	16.09±0.23^{bc}	16.27±0.30^{b}	4.23±0.10^{c}
4PPI	14.81±0.19^{c}	73.50±0.48^{c}	19.31±0.18^{d}	16.51±0.16^{c}	16.13±0.21^{b}	4.36±0.07^{c}
Broken	14.00±1.13^{bc}	78.50±2.80^{c}	19.00±1.04^{bcd}	16.50±0.93^{bc}	15.25±1.22^{ab}	3.75±0.42^{abc}
Sex	***	NS	***	**	NS	NS
Female (F)	14.15±0.16^{a}	72.28±0.39	18.56±0.15^{a}	16.03±0.12^{a}	15.91±0.15	4.11±0.06
Male (M)	12.05±0.36^{b}	72.16±0.91	16.71±0.34^{b}	15.06±0.29^{b}	15.35±0.35	3.93±0.13

PW=Pelvic width, PH=Pelvic height, RW=Rump width, RL=Rump length, TL=Tail length and TW=Tail width.*Means with the same letter within the same column are not significant.* * Significant at 0.05level= p≤0.05, ** significant at 0.01 level = p≤0.01 and *** significant at 0.001 level = P≤0.001,LSM=least square mean, NS=not significant, SE= Standard error and PPI =pair of permanent incisors

Averages wither height (WH) for dairy, dual and meat type goats were 72.16±0.61, 69.05±0.72 and 70.66±0.77cm, respectively. Dairy type goats have significantly ($p<0.05$) higher wither height than dual and meat type goats. Wither height of the present dairy goats was comparable to the result of Nubian goats which have 70.1cm wither height [17] and 25-36 months and above female Beetal goats which have 71.42±2.31 cm [14]. Alpine and Saanen goats in Hungary have a wither height of 67.92±4.21 cm and 67.43±3.85 cm, respectively which was lower than the present wither height [13].

Dairy type goats have significantly higher ($p<0.05$) average pelvic width (15.05±0.20 cm) than dual (13.09±0.24 cm) and meat (12.70±0.25 cm) type goats. Alpine and Saanen goats have 17.21±1.07 and 18.49±2.29 cm, respectively pelvic width in Hungary, which is higher than the present finding [13]. Similarly, pelvic height (PH) of dairy type goats (73.37±0.54 cm) was significantly higher ($p<0.05$) than dual (71.42±0.64 cm) and meat (71.44±0.68 cm) type goats.

Average rump width (RW) and rump length (RL) were 19.31±0.19 cm and 16.61±0.16 cm for dairy type goat, 17.61±0.23 cm and 15.29±0.19 cm for dual type goat and 17.35±0.25 cm and 15.37±0.21cm for meat type goat (Table 3). Dairy type goats have significantly higher ($p<0.001$) values for rump width and rump length than dual and meat type goats. The present result of rump width for dairy type goats was higher than Beetal goats which have a rump width of 15.4±2.60 and 17.6±3.55 cm in the front and 14.7±1.15 and 16.5±1.68 cm towards back in

Fig. 2: Dairy type, Dual goat type and Meat type goat In Gonji kolela district from left right, respectively)

Table 4: LSM±SE Rear udder diameter, rear udder length, udder circumference, teat length, scrotum length, scrotum width and scrotum circumference for goat type and district

	RUD	RUL	UCC	TTL	SL	SW	SCC
Effects and Level	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Grand	9.21±0.17	15.55±0.24	28.63±0.48	3.46±0.05	12.69±0.42	8.88±0.35	23.56±0.66
Goat type	***	***	***	***	NS	NS	NS
Dairy	10.04±0.22 [a]	17.14±0.28 [a]	31.39±0.59 [a]	3.71±0.07 [a]	13.75±1.09	9.37±0.89	23.75±1.74
Dual	8.66±0.37 [b]	14.21±0.48 [b]	26.75±1.01 [b]	3.41±0.12 [b]	12.85±0.69	9.20±0.56	24.26±1.10
Meat	8.01±0.30 [b]	13.44±0.38 [b]	24.67±0.81 [b]	3.01±0.09 [c]	12.21±0.63	8.44±0.52	22.92±1.00
District	NS	NS	NS	NS	NS	*	*
Ebnat	9.07±0.29	15.78±0.40	28.52±0.82	3.42±0.09	13.03±0.56	9.45±0.43[a]	24.71±0.82[a]
Farta	9.10±0.31	15.24±0.43	28.14±0.88	3.52±0.10	12.23±0.65	8.09±0.50[b]	22.00±0.95[b]
Gonji ko	9.45±0.29	15.60±0.40	29.16±0.82	3.44±0.09	Nm	Nm	Nm

RUD=Rear Udder Diameter, RUL=Rear Udder Length, UCC=Udder Circumference, TTL=Teat Length, SL= Scrotum Length, SW= Scrotum Width and SCC= Scrotum Circumference. *Means with the same letter within the same column are not significant* * Significant at 0.05level= p≤0.05, ** significant at 0.01 level = p≤0.01 and *** significant at 0.001 level = P≤0.001;LSM=least square mean, Na= not applicable, Nm= not measured, NS=not significant and SE= Standard error.

females and males, respectively. However, the finding of rump length of dairy type goat is comparable to Beetal goats which have a rump length of 15.8±1.12 and 17.3±1.12 cm, for females and males, respectively [15].

The average tail length (TL) and tail width (TW) for dairy type goat was 16.29±0.21 cm and 4.40±0.07 cm, respectively. The corresponding values were 15.61±0.24cm and 3.82±0.09cm, respectively for dual type goat and 15.32±0.26cm and 3.89±0.09cm, respectively for meat type goats. Dairy type goats have significantly higher values for tail length and tail width than dual and meat type goats. Beetal female and male goats have 18.9±2.39 cm and 20.8±2.61 cm tail length, respectively, which was higher than the present finding. However, tail width of dairy goats in this finding is higher than Beetal goats in Pakistan, which have a diameter of 3.2±0.30cm at the base [15].

Identification of Goat Types Based on Dairy Specific Traits: Average rear udder diameter (RUD) for dairy, dual and meat type female goats were 10.04±0.22, 8.66±0.37 and 8.01±0.30 cm, respectively. Rear udder length (RUL), udder circumference (UCC) and teat length (TTL) in these breeds averaged were 17.14±0.28, 31.39±0.59 and 3.71±0.07cm, 14.21±0.48, 26.75±1.01 and 3.41±0.12cm and 13.44±0.38, 24.67±0.81 and 3.01±0.09 cm, respectively (Table 4 and Fig. 2). In this finding, dairy type female goats have significantly higher ($p<0.001$) values for all udder and teat measurements than dual and meat type female goats. Greater than two years West African Dwarf (WAD) goat have12.00 ± 0.34 cm udder width in semi-intensive management system in Nigeria, which was higher than the present rear udder diameter. However, udder circumference (25.44±0.58 cm) and teat length (2.40 ± 0.11 cm) of greater than two years WAD goat in Nigeria were lower than the present dairy type goats [18].

Scrotum length, scrotum width and scrotum circumference were 13.75±1.09, 9.37±0.89 and 23.75±1.74 cm in dairy type male goats, 12.85±0.69, 9.20±0.56 and 24.26±1.10 cm in dual male goats and 12.21±0.63, 8.44±0.52 and 22.92±1.00 cm in meat type male goats, respectively. There was no a significant differences ($p>0.05$) among goat types for all scrotum measurements. Average scrotum length of Beetal male goats was 12.6±1.68 cm, which were closer to the present finding. However, average Scrotum circumference of Beetal male goats was 25.4±1.37 cm, which was higher than the present finding [15].

Conclusions and Recommendations: From the study, it was possible to see goat farming is an important component of the farming activity. However, farmers did not use product specific specialized production system for dairy goat types; meat types and so on. of course, there were significant differences between indigenous dairy type goats from indigenous dual and meat type goats in almost all traits, especially reproductive traits of dairy type doe such as rear udder diameter, rear udder length, udder circumference, teat length shows higher significant differences ($p<0.001$) from dual and meat type does. In addition, the result of the present indigenous dairy type goats is comparable to other internationally known dairy goat breeds. However, farmers did not select goats for specific purpose. This study confirmed that there are indigenous dairy type goats in the areas. Its differences can be interesting in the future, when the development of indigenous dairy type goat selection will start. However, goat production was constrained by high disease prevalence, feed shortage, lacks of improved genotypes, predators and other problems. Thus, technological intervention is crucial to alleviate the identified constraints for the improvement of dairy goat production in the studied areas. As a result, specialized and intensive dairy, meat and dual purpose goat production including improved feeding, housing, health and management practice with selection and multiplication of superior dairy type goats is recommended to increase product specific goat types and production system to improve the livelihood of the farmers.

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