Research Article

The Choice of Breeding Objectives and Selection Criteria Decided by Breeders of Various Goat Breeds and Factors Influencing Them

Mohammad J Tabbaa[1], Maher M Baker[2], Faisal S Barakeh[2]

1. School of Agriculture, Department of Animal Production, University of Jordan, Jordan; 2. Independent researcher

Knowledge of breeding objectives and selection criteria is essential for a successful breeding program. A questionnaire was prepared and distributed among breeders of various goat breeds in the Abu-Dhabi Emirate to explore their breeding objectives and selection criteria for the various goat breeds that they raise. A total of 293 different goat herds, with a total of 49,911 heads of goats, were investigated. A stepwise logistic regression was applied using the LOGIST procedure of SAS. The results suggest that goat breeders in the UAE are breeding goats mainly for meat production (94%), adaptability to the environment (40%), and disease resistance (35%). Only a few breeders considered milk production (21%) as a breeding objective. Factors that influenced breeders' decisions on breeding objectives were the breed of goat, region, property type, and herd size. Nine out of the twelve doe selection criteria chosen by goat breeders are considered objective selection criteria, and only three are subjective selection criteria. Growth rate, fertility, twinning ability, and body morphology selection criteria were considered the most important on average by Emirati goat breeders, with a medium proportion (60–65%). Goat breeders have put slightly more pressure on buck subjective criteria. The most important buck selection criteria were growth rate (80%) and body morphology (76%), then fertility, buck being one of twins, and breed purity, with averages of 50-55%. Although increasing meat production was the main breeding objective, an effective breeding program must incorporate different selection criteria for does and bucks, considering differences in breeds, regions, property types, and herd sizes.

Corresponding author: Mohammad Tabbaa, MJTabbaa@JU.Edu.Jo

 doi.org/10.32388/WWA5M9.2

Highlights

- The main breeding objective for Abu-Dhabi goat farmers was meat production
- Breed, region, property type, and flock type and size influenced breeding objectives
- Three out of twelve selection criteria were subjective criteria
- Growth rate and body morphology were the most important buck selection criteria

Introduction

Goats are important farm animals raised for meat, milk, hide, and fiber. They are greatly adaptable to a wide variety of environmental conditions and production systems. As a result, there are over 576 breeds available worldwide, and their population is growing [1][2]. The goat population in the United Arab Emirates is also increasing; according to the Statistics Book [3], there were more than 1.3 million head of goats in the Abu-Dhabi Emirate, representing more than 37% of the overall animal heads in the Emirate. Although raising goats in the United Arab Emirates is considered a part of the Emirati tradition, it is economically inefficient in terms of input use [4]. This is because most goat breeders in the UAE do not raise goats for revenue; in contrast, they consider it a hobby and as a source of milk and meat mainly used for family consumption. Breeders select a breed based on its morphostructural and production characteristics. Maintaining biodiversity among breeds requires distinctive breeding objectives for each breed. However, breeders often concentrate on morphostructural traits more than production traits as criteria for selection [5][6]. Several goat breeds were observed in the Emirate during a preliminary investigation, and breeders were attempting to improve productivity by random crossing of different breeds. These breeds of goats were imported and found in many countries of the region. Understanding the breeding objectives and selection criteria of the farmers assists in improving the various goat breeds found in the region, though there is no animal breeding program for improving goats, and data is lacking on breeders' beliefs about the breeding objectives of the different goat breeds they own.

The traditional method for determining breeding objectives is by using mathematical equations related to profit that take into account cost and return constituents to derive economic weights that quantify the genetic change [7]. However, definitions of breeding objectives through research may not be adopted in reality if they do not reveal the beliefs of the breeders. The failure of many breeding programs aiming to genetically improve livestock breeds was mainly due to the absence of breeders' opinions in outlining breeding objectives for their animals [8][9]. Traditional economic values often fail to notice the meandering

value of subjective traits that may be profitable under certain conditions, characteristics related to animal wellbeing, and impact on the environment that could affect breeders' decisions despite the fact that they are not easy to define [10][11]. Recently, other approaches were used to derive breeding objectives for animal improvement programs, such as using specified-preference practices by consumers or breeders. In these practices, questionnaires are prepared to ask breeders to pick from multiple-choice questions [12]. For animal breeders, this attitude involves analyzing breeders' preferences in relation to their belief in the paybacks that might be achieved through genetic improvement [13][14]. Many factors could affect the breeders' choice of breeding objectives and selection criteria; these include region, production system, breed, housing type, and herd size [5][6][15]. Low fertility in commercial beef farms is acknowledged by some breeders in South Africa, while it is not accepted in other types of farming where breeders are aiming for high fertility [16]. In the United Arab Emirates, no studies have been found so far identifying the breeding objectives and selection criteria applied by Emirates goat breeders. Therefore, this investigation is a substantial effort to realize the breeders' desires from different goat genetic resources in the UAE. This will be valuable to breeders to improve the productivity of their animals and to provide an applicable genetic improvement program. The aim of this study is to explore the breeding objectives and selection criteria recognized by breeders of various goat breeds and to examine the potential factors that might affect their decisions.

Material and Methods

Study area

The study was conducted in the three regions of Abu-Dhabi Emirate: Abu-Dhabi, Al-Dhafra, and Al-Ain, with their sub-regions, between December 2015 and September 2016. The Emirate is located between 22°40" and 25°N and 51° and 56°E, and it is a hot desert area with low rainfall, and its skies are clear all year round. The average maximum annual temperature exceeds 39°C with high humidity during the period from June to September, while cooler temperatures (19°C) are experienced from November to March.

Sample selection

A stratified random sample of 230 goat breeders from all regions was interviewed based on the number of goats in each sub-region [17]. The sample was selected by interviewing 5 breeders per one percent of the goat population, with a minimum of 3 breeders in each sub-region. Selected breeders possess a total of 293 herds of various goat breeds with a total of 49,911 heads of goats.

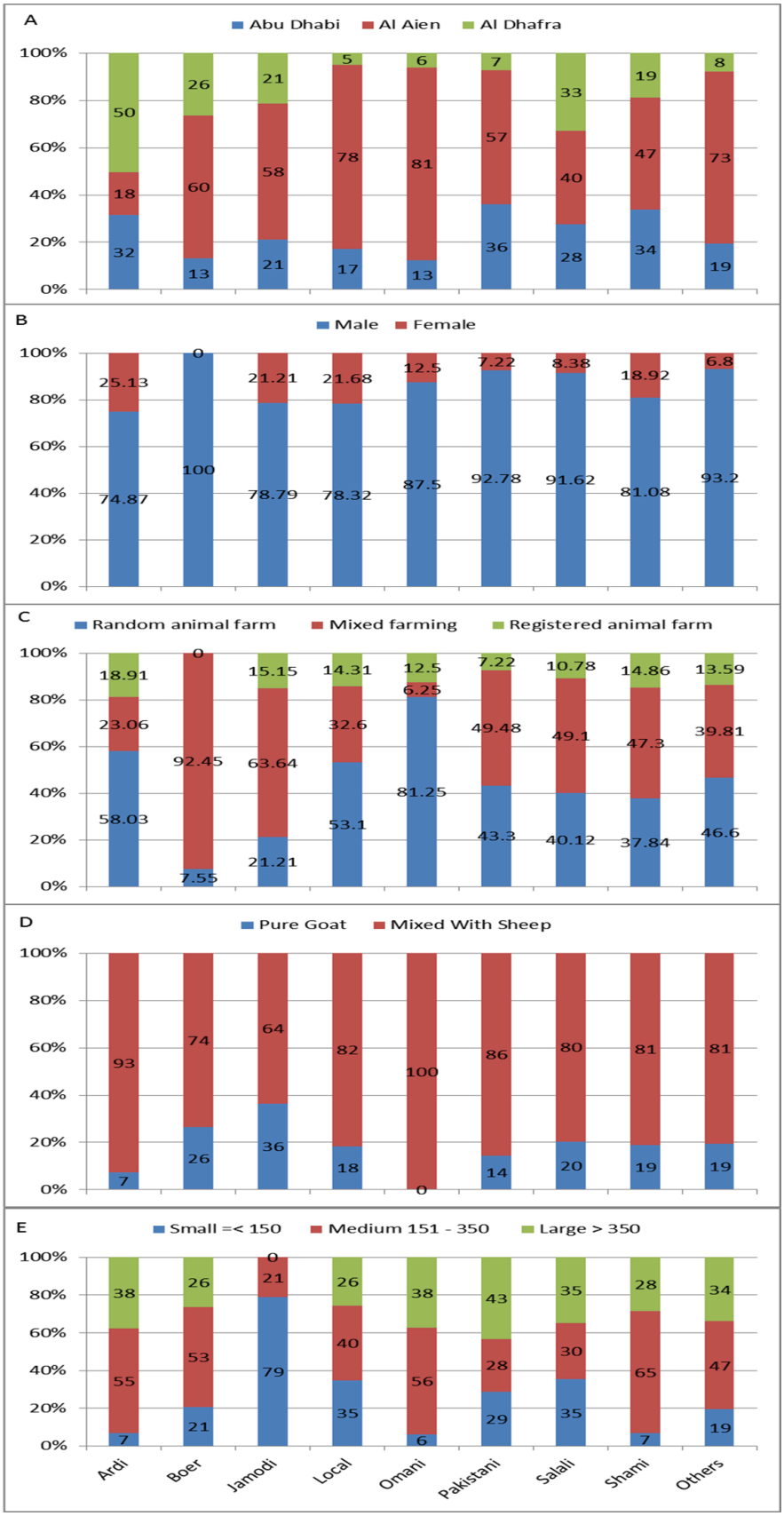
The government does not allow breeders to graze their animals outside their properties. Three property types are found: random and registered animal farms, and mixed farms of animals and plants [18]. The registered animal farms and mixed farms were originated by the municipalities as a group of farms and distributed among the local breeders. However, random animal farms were originated by a group or single breeders in random places, and they were not registered. Both types of animal farms (registered and random) were allowed to raise only various species of animals but not to grow crops or trees, while mixed farms are allowed to grow crops, vegetables, and trees and raise animals. Two types of herds were found, one of which is pure goat or mixed with sheep. If the number of adults was up to 150 heads, herds were categorized as small; if the number of adults was between 151 to 350 heads, herds were categorized as medium; and large herds with adult animals were more than 350 heads.

Breeders interview

A questionnaire was prepared and tested to collect data related to goat breeding in the Emirate. A trained interviewer specifically asked the breeders about their goat herd breeds, herd size, productivity characteristics, breeding objectives, and selection criteria for their replacement does and bucks, and if they were homegrown or brought from other herds. The questionnaire also included additional information with respect to the geographical site, farm location, and the gender of the owner. Breeds that were only found in one or two farms were grouped as one group called "Others".

Statistical analysis

Survey data were statistically analyzed using the Chi-square test of the FREQ procedure of the Statistical Analysis System (SAS) [19]. In the initial statistical analysis, owner gender was assumed as a factor; however, no criteria were affected by gender (Figure 1B). After that, stepwise logistic regression was applied using the LOGIST procedure of SAS [19] to study the influence of available factors on breeding objectives and selection criteria and to calculate the odds ratios to estimate the comparative importance of the different levels of influences on breeders' choices.



doi.org/10.32388/WWA5M9.2

Figure 1. Distribution of goat breeds in different A) regions, B) gender ownerships, C) property types, D) herd types, and E) sizes in the Abu-Dhabi Emirate, UAE.

Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi, and Somali. All distributions were significantly different among breeds ($P < 0.0001$).

Results and Discussion

Breeding objectives

Table 1 presents the breeding objectives chosen by Emirati breeders for different goat breeds. The results suggest that goat breeders in the UAE are breeding goats mainly for meat production (94%). This is in agreement with Malawi goat breeders [20]. Elsewhere, the most important breeding objectives for goats were cash income from the sale of live goats and, in second place, meat and milk production for home consumption [21][22]. Goat meat is preferred by many local people of the UAE, with a growing demand for it in the market of the Gulf States [21]. Other researchers reported multiple breeding objectives chosen by breeders to improve the productivity of their goats, including meat and milk for home consumption, cash from selling live animals, insurance against emergency, wealth, dowry, and manure [23][24]. Although differences were not significant ($P > 0.1$), numerically some breeds were 100% raised for meat production, such as Boer, Omani, and Pakistani goats, while only 82% of the Shami (Damascus) goat breeders chose meat production as a breeding objective for their goats.

Breed	N	MP	AE	DR	KP	BU	FP
P-value		0.3168	0.3709	0.0236	0.0007	0.0093	0.0003
Ardi	61	97	44	43	36	20	7
Boer	10	100	50	60	30	30	0
Crossbred	16	94	56	56	38	31	25
Jamodi	7	86	29	14	0	14	0
Local	109	93	36	31	7	4	0
Omani	14	100	14	7	29	0	0
Pakistani	19	100	37	42	32	11	0
Salali	28	93	46	29	18	14	4
Shami	11	82	27	9	36	18	0
Others	18	83	50	44	22	11	6
Overall Average	293	94	40	35	21	12	3

Table 1. Proportions of breeders selecting the breeding objectives for the different goat breeds in Abu-Dhabi Emirate.

MP: Meat production, AE: Adaptability to environment, DR: Disease resistance, KP: Milk production, BU: Breed unique morphology, FP: Fiber production. Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi, and Somali.

The second most important breeding objective for goats was the adaptability to the environment (40%, Table 1). Also, this breeding objective was not significantly ($P > 0.1$) different among different breeds. However, breeders raising exotic breeds, such as Boer, Others breeds, and crossbred goats, gave more attention to adaptability to environmental conditions (50 – 56%) than those raising local breeds (36%) or breeds from adjacent countries such as Omani (14%); which is a justifiable decision, since the latter breeds are already adapted to the harsh environmental conditions dominating the Gulf States. Disease resistance was considered by a reasonable proportion of breeders (35%) as a breeding objective with differences

among different goat breeds (Table 1). Similar to adaptability to the environment, disease resistance was more considered by breeders of exotic breeds. Though more pronounced, significant ($P < 0.05$) differences were revealed between exotic and local breeds. For instance, 60% of the Boer, 56% of crossbred, 44% of Others breeds, 43% of Ardi, and 42% of Pakistani goat breeders considered disease resistance, while only 7% of the Omani, 9% of Shami, and 14% of Jamodi goat breeders considered this breeding objective (Table 1).

Milk production was considered by only 21% of the breeders as a breeding objective (Table 1). This is because most breeders in the UAE do not sell or process goat milk. They either consume it fresh or leave it for the labor and the goat kids to consume. On the contrary, breeders in many countries consider milk production as the main breeding objective for goat keeping [5][24]. In Brazil and other industrialized countries, breeders consider not only milk yield but also milk quality [25]. Anyway, a goat improvement strategy should consider breeders' breeding objectives and their traditional breeding practices [23]. Although milk production as a breeding objective was highly significant ($P < 0.01$), differences among breeders of different goat breeds were found. Shami, Ardi, Pakistani, and Boer breeds, in addition to the crossbred goat breeders, gave attention to milk production only between 30% and 38%. However, only breeders of Shami and Pakistani goats were most likely to milk their goats.

Fewer breeders considered breed unique morphology (12%) and fiber (3%) as breeding objectives (Table 1). For both breeding objectives, highly significant ($P < 0.01$) differences were found among breeders of different goat breeds. More Boer goat breeders than Ardi and Shami breeders emphasized body morphology (30%, 20%, and 18%, respectively) as a breeding objective for their goats than other purebred breeders. These three breeds are always displayed at livestock shows in the Emirate and judged on their unique morphological characteristics. Breeders in Jordan emphasized the unique morphological characteristics of each breed, as it was the second most important breeding objective with a higher proportion of breeders (46%) selecting Shami goats for them [5]. Although multiple breeding objectives were considered by breeders in Ethiopia, they emphasized the breed unique morphology [23]. Breeders, in general, believe that the breed unique morphology is related to high productivity in a breed; therefore, selection for unique morphology improves productivity [5]. On the other hand, fiber is mostly of no value to breeders in the UAE, though 25% of the crossbred goats' breeders considered fiber as a breeding objective for their goats with no clear reason.

Factors influencing breeding objectives

Many factors influenced breeders' breeding objectives, including breed, region, property type, and herd size (Table 2). Similarly, in Ethiopia, breeders' decisions on breeding objectives differed due to the breed raised [23]. The breed of goat significantly influenced breeders' decisions on disease resistance, milk production, and breed unique morphology. The odds ratio (OR) revealed that the breeders of Shami and Omani goats were the least worried about disease resistance, then the breeders of Jamodi and Salali goats, and then the other breeders. This could be because these breeds were more resistant to diseases than other breeds raised under the UAE conditions. Regarding the breeding objective of milk production, the breeders most concerned were those of crossbred, Shami, and Ardi goats, and the least concerned were those raising Jamodi, followed by Local goats. Ardi goats' breeders were the most worried about breed unique morphology, then Boer goats' breeders, and then breeders of Shami and Salali goats.

Factor	AE	DR	KP	BU
Breed P-value		0.0151	0.0006	<0.0001
Ardi vs. Others		0.59	1.82	11.57
Boer vs. Others		1.13	1.63	6.46
Crossbred vs. Others		1.51	1.89	4.95
Jamodi vs. Others		0.09	0.00	0.79
Local vs. Others		0.40	0.23	0.21
Omani vs. Others		0.08	1.19	0.00
Pakistani vs. Others		1.36	1.34	1.03
Salali vs. Others		0.26	0.64	2.73
Shami vs. Others		0.08	1.84	2.98
Region P-value	<0.0001	<0.0001		0.0004
Abu-Dhabi vs. Al-Dhafra	0.03	0.05		0.49
Al-Ain vs. Al-Dhafra	0.35	0.35		19.50
Property type P-value			0.0177	
Random vs. Registered animal farm			0.34	
Mixed farming vs. Registered animal farm			0.32	
Herd size P-value		0.01		0.0393
Small =< 150 vs. Large > 350 heads		3.01		3.43
Medium 151 - 350 vs. > Large 350 heads		1.14		0.81

Table 2. Factors influencing the selection of different breeding objectives for goat breeds and their odds ratios in Abu-Dhabi Emirate.

AE: Adaptability to environment, DR: Disease resistance, KP: Milk production, BU: Breed unique morphology.

Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi, and Somali.

doi.org/10.32388/WWA5M9.2

The region of Abu-Dhabi Emirate has a highly significant ($P < 0.01$) influence on the breeders' breeding objectives toward adaptability to the environment, disease resistance, and unique morphology of the breed (Table 2). Likewise, breeders in other countries have different breeding objectives in different regions, as some are more concerned with economic traits like meat, milk, and cash income and disease resistance, while others emphasize the breed unique morphology [24][26]. The influence of region on breeders' decisions regarding breeding objectives may reflect differences due to ecological and social factors, as well as economic and marketing opportunities available in different regions [25]. Breeders in the Al-Dhafra region were extremely more concerned about adaptability to the environment and disease resistance than breeders in both the Al-Ain and Abu-Dhabi regions, and those of Al-Ain were more concerned than those in Abu-Dhabi. In general, the Al-Dhafra region has harsher environmental conditions than the other two regions, and more facilities like fresh water and clinics are available for breeders in these two regions than for breeders of the Al-Dhafra region. Similarly, breeders in the Al-Ain region were more likely to select goats for the breed unique morphology than those in the other regions of the Emirate, though the differences in OR (19.50) were higher than for the previous two objectives. Figure 1A displays the distribution of different breeds in the three regions, which was highly significantly different ($P < 0.01$). In general, more than 57% of the surveyed goat population is in the Al-Ain region. However, more than 50% of Ardi goats were found in the Al-Dhafra region.

Property type, which might reflect the production system, significantly ($P < 0.05$) affected the breeders' decision to select for milk production (Table 2) and with breeds' scattering significantly ($P < 0.01$) different among different property types (Figure 1C). Breeding objective definitions by breeders often reveal the relative social and economic importance of certain characters within a production system [23][27]. Breeders who are owners of registered animal farms were more likely to select for higher milk yield than those of other property types. It is good to know that more than 51% of the overall sampled goats were in the random animal farms, while around 14% were found only in the registered animal farms, which might have contributed to breeders' decision to select for milk production under the registered animal farms (Figure 1C).

Herd size significantly affected breeders' decision to select for disease resistance ($P = 0.01$) and breed unique morphology ($P < 0.05$), with small herds being the most in both characteristics (Table 2). This indicates that breeders of small herds are more interested in selecting their goats to be more resistant to diseases and to fit more with breed unique characteristics. Breed distribution in different herd sizes was

significantly different (P < 0.01, Figure 1E), with medium-sized herds having more than 42% of the entire goat population.

Selection criteria of does

Doe selection criteria for the replacements of different goat breeds are presented in Table 3. Nine out of the twelve selection criteria were considered objective selection criteria, and only three were subjective selection criteria. Similarly, breeders in Ethiopia also select for subjective and objective selection criteria [24]. The three subjective selection criteria were the first (body morphology 60%), which was among the most important, the second (breed purity 40%), which was in the middle, and the third (doe sources 18%), which was the least important to breeders of the different goat breeds. Multiple selection criteria were considered by breeders in other countries [5][21][22][24]. Choosing body morphology and performance characteristics as selection criteria by the breeders suggests that breeders are selecting their animals on a two-stage procedure; first, they use body morphology and family history in the early stage of life, then use production and reproduction characteristics at a later stage [21]. Fertility, twinning ability, body morphology, and growth rate selection criteria were considered the most important on average by goat breeders in the Abu-Dhabi Emirate, with a medium proportion of breeders choosing them (60% – 65%). Fertility traits, twinning ability, and growth rate were among the most important selection criteria reported by several researchers [22][23]. Fertile does that produce twins with a high rate of kidding are favored by the breeders because they contribute more to their income [23]. However, some breeders revealed that twinning is not welcomed because does with twins produce weak kids that might not survive the harsh environment of the UAE. Many other criteria were also reported as most important, such as milk yield, age at first kidding, body morphology, and color [21][22][24]. In general, breeders believe that selection for some body morphology characteristics is a tool for the improvement of meat and milk productivity and longevity traits [5][23][24]. Tabbaa and Al-Atiyat [5] found that goat breeders in Jordan were most concerned with doe source as a selection criterion for their replacement does. Fertility and twinning ability were not significantly different among goat breeds, while growth rate and body morphology were significantly (P < 0.01) different among breeds. The highest percentage of breeders considering growth rate and body morphology as selection criteria was for crossbred goats (92%); however, for Boer goats, it was 80%. This might signify the importance of these criteria for crossbreeding goats. A high proportion of breeders considered growth rate criteria for Ardi, Pakistani, and Omani goats. Similarly, body morphology was highly considered by Shami goat breeders and breeders of the Others breeds.

Disease resistance was considered next by goat breeders for their doe selection criteria, with no significant differences among breeds (52%, Table 3). Goat breeders were also concerned with average merit, kidding ease, and breed purity selection criteria, with proportions ranging from 40% to 47%. Kidding ease and breed purity were significantly ($P < 0.01$) different among different breeds. Kidding ease was the most concern for crossbred goats (92%), which might be due to the fact that crossing large breed bucks with smaller does, in order to obtain kids with a high growth rate, creates a kidding problem for these does. Breed purity was most important for Boer goats (90%); this is because of the high value of this exotic breed in the market of the Emirate. Last season productivity and dam merit were important for 33% – 35% of the goat breeders, with significant ($P < 0.01$) differences among different breeds. Kebede et al. [23] stated that breeders in some parts of Ethiopia consider dam merit as the second most important doe selection criterion after milk yield. Longevity (25%) and doe source (18%) were the least concerned selection criteria by goat breeders. A sustainable and successful breed improvement program needs to include all different categories of selection criteria requested by breeders that improve production efficiency to enhance economic gain; however, the ease of measurement of selection criteria should also be considered [21][28]. The breeding programs should also be designed considering good management practices such as better feeding and health, in addition to good selection criteria [21].

Breed	No	FR	TA	GR	BM	DR	AM	KE	BP	LS	DM	LG	DS
P-value		0.2221	0.8484	0.006	0.0015	0.0694	0.3417	0.0002	<0.0001	<0.0001	<0.0001	0.0867	0.0003
Ardi	55	67	69	78	69	66	46	60	51	51	42	22	31
Boer	10	40	60	80	80	50	60	30	90	30	50	30	20
Crossbred	13	85	77	92	92	77	54	92	54	69	77	54	54
Jamodi	6	83	50	50	67	67	33	17	33	67	17	17	17
Local	108	60	64	58	44	47	39	36	18	15	17	19	6
Omani	15	80	67	73	67	27	53	33	53	40	47	33	27
Pakistani	20	60	65	75	65	35	45	25	45	45	35	10	10
Salali	27	74	56	59	59	56	63	59	56	41	37	37	22
Shami	12	83	83	42	75	42	67	42	67	42	67	42	25
Others	17	59	65	35	82	59	59	24	47	41	29	29	18
Overall Average	283	66	65	64	60	52	47	44	40	35	33	25	18

Table 3. Proportions of breeders selecting doe selection criteria for the different goat breeds in Abu-Dhabi Emirate.

FR: Fertility, TA: Twinning ability, GR: Growth rate, BM: Body morphology, DR: Disease resistance, AM: Average merit, KE: Kidding ease, BP: Breed purity, LS: Last season productivity, DM: Dam's merit, LG: Longevity, DS: Doe source. Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi, and Somali.

Factors influencing selection criteria of does

Doe breed significantly ($P < 0.01$) affected breeders' decisions on selection criteria toward body morphology, kidding ease, breed purity, last season productivity, dam's merit, and doe source (Table 4). Differences in breeders' decisions on selection criteria due to breed were stated by other researchers [23]. Crossbred goats' breeders were the most concerned with body morphology as a selection criterion for their replacement does, as the odds ratio shows (2.49), followed by Boer (1.39), with other breeders then

following. The odds ratio also revealed that crossbred goats' breeders were the most worried about their replacement does with several other selection criteria, including kidding ease, last season productivity, dams' merit, and their doe replacement source. Salali goat breeders come next in kidding ease, Jamodi goats' breeders come next in last season productivity, Shami goat breeders come second in dam merit, and Ardi goat breeders come next in doe replacement source. Boer goats' breeders were the most concerned with breed purity for their replacement doe selection criteria, with Shami goat breeders coming next (Table 4).

The region where the farm is located significantly influenced several doe selection criteria, including growth rate, body morphology, disease resistance, kidding ease, breed purity, last season productivity, and dams' merit (Table 4). Similarly, Asefa et al. [24] reported significant differences in breeders' decisions on selection criteria in different regions of the same country. Regional differences may reflect environmental condition differences or differences in marketing opportunities [24][28]. Therefore, in order to have a successful breeding program, different selection criteria and selection strategies need to be adopted in different regions, even for the same breeding objectives [20]. As the odds ratio revealed, breeders in the Abu-Dhabi region were the most concerned about body morphology and growth rate as selection criteria for their replacement does, while Al-Ain breeders were the most concerned with breed purity and dams' merit. On the other hand, Al-Dhafra breeders were the most concerned with disease resistance, kidding ease, and last season productivity.

Property type, which represents the production system in the UAE, significantly influenced the breeders' decisions on doe selection criteria toward twinning ability, growth rate, body morphology, and disease resistance (Table 4). The production system was reported to influence breeders' decisions on selection criteria [23]. Breeders of the registered farms were the most concerned about twinning ability and growth rate, while breeders of the random farms were the most concerned with body morphology and disease resistance. Breeders of the mixed farms were in the middle for all selection criteria except for body morphology, for which they were the least concerned.

It is important to mention that breed distribution among different herd types was significantly ($P < 0.01$) different and that almost 85% of the herds were mixed with sheep (Figure 1D). Herd type significantly influenced the breeders' decision on only two doe selection criteria, one of which is the growth rate and the other is last season's productivity (Table 4). The odds ratio revealed that pure goat breeders were concentrating more on last season's productivity (3.22) and less on growth rate (0.38). On the other hand, herd size significantly influenced fertility, breed purity, and last season's productivity (Table 4). Breeders of

small herd sizes were concentrating on fertility and breed purity, while large herd breeders were more concerned with last season's productivity.

Selection criteria of bucks

Decisions on replacement buck selection criteria for different goat breeds are presented in Table 5. Similar to doe selection criteria, nine out of twelve selection criteria are considered objective selection criteria, and only three are subjective selection criteria. However, Abu-Dhabi Emirate breeders have put slightly more pressure on buck subjective criteria than on those for does (Table 3). Similarly, breeders in Ethiopia slightly put more pressure on morphological characteristics for replacement buck selection than on doe selection criteria [23]. However, Jordanian breeders put more pressure on bucks' objective selection criteria than on those for does [5]. The most important buck selection criterion for the Emirati breeders was growth rate (80%), with no significant differences among different breeds; however, the percentage of breeders considering this criterion ranged from 67% for Salali and Shami goats to 100% for Boer and crossbred goats (Table 4). Abraham et al. [22] (2017) reported that breeders emphasized growth rate, body size, and libido as selection criteria for bucks. On the other hand, Kebede et al. [23] stated that growth rate and prolificacy of bucks were considered by the breeders as the least important criteria for buck selection.

Factor	FR	TA	GR	BM	DR	KE	BP	LS	DM	DS
Breed P-value				0.0015		<0.0001	<0.0001	<0.0001	<0.0001	0.0003
Ardi vs. Others				0.54		2.38	2.39	1.17	3.08	2.09
Boer vs. Others				1.39		0.70	15.94	0.35	3.43	1.17
Crossbred vs. Others				2.49		37.98	1.63	3.26	10.58	5.44
Jamodi vs. Others				0.51		0.43	0.43	2.90	0.54	0.93
Local vs. Others				0.14		1.83	0.23	0.29	0.50	0.28
Omani vs. Others				0.28		1.66	1.60	1.04	2.26	1.70
Pakistani vs. Others				0.30		0.80	1.30	1.33	1.66	0.52
Salali vs. Others				0.32		3.06	1.90	0.80	2.06	1.33
Shami vs. Others				0.70		1.77	3.44	0.93	6.43	1.56
Region P-value			<0.0001	0.0044	<0.0001	0.0049	0.042	0.0022	0.0342	
Abu-Dhabi vs. Al-Dhafra			2.05	6.92	0.18	0.24	0.99	0.19	1.49	
Al-Ain vs. Al-Dhafra			0.43	2.75	0.19	0.17	2.46	0.29	2.79	
Property type P-value		0.0005	0.0002	0.0419	0.0283					
Random vs. Registered animal farm		0.16	0.07	1.78	3.16					
Mixed farming vs. Registered animal farm		0.26	0.09	0.73	2.26					
Herd type P-value			0.005					0.0462		
Pure goat vs. Mixed			0.38					3.22		
Herd size P-value	0.0001						0.041	0.0293		
Small =< 150 vs. Large > 350 heads	1.15						2.11	0.34		
Medium 151 - 350 vs. Large > 350 heads	0.36						0.84	0.50		

doi.org/10.32388/WWA5M9.2

Table 4. Factors influencing selection of doe selection criteria for goat breeds in Abu-Dhabi Emirate.

FR: Fertility, TA: Twinning ability, GR: Growth rate, BM: Body morphology, DR: Disease resistance, KE: Kidding ease, BP: Breed purity, LS: Last season productivity, DM: Dam's merit, DS: Doe source. Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi, and Somali.

Body morphology as a selection criterion (76%) was the second most important for the breeders after growth rate, with no significant difference among different breeds (Table 5). Similarly, Ahmed et al. [21] reported that breeders ranked body morphology as second for buck selection criteria. However, Asefa et al. [24] found that breeders put body morphology in the first rank for both bucks and does selection, since they consider body morphology a tool for improvement of performance characteristics. The range of percentage values for breeders choosing this criterion for their different breeds was from 66% for Local goats to 95% for Pakistani goats, though the value for Shami and crossbred breeders was 93%.

Fertility, the buck being one of twins, and breed purity came in third place as selection criteria with averages of 50 - 55%. Fertility characteristics for buck selection such as testicular characteristics, libido, and prolificacy were emphasized by breeders elsewhere [22][23]. Fertility was most considered by breeders of Ardi (74%), Boer (70%), Shami (67%), and crossbred (67%) goats with a significant difference ($P < 0.05$) among different breeds, while the buck being one of twins was considered most by breeders of Boer and crossbred (80%), then by breeders of Shami (67%) with a trend ($P < 0.1$) of differences among breeds. Breed purity was most considered by breeders of Boer (90%) and Jamodi (86%) goats and least by breeders of the Local (24%) breed of goat.

On average, disease resistance, mortality rate, and kidding ease came next in importance as buck selection criteria for Emirati goat breeders (Table 5). Disease resistance (67%), mortality rate (67%), and kidding ease (87%) were most considered by breeders of crossbred goats, while least considered by Omani goat breeders (6%, 0%, and 13%, respectively, for the three criteria).

The bucks' dam merit and her twinning ability were considered on overall breeds' average, respectively by 28% and 26% of the goat breeders (Table 4). On the contrary, Kebede et al. [23] reported dam merit or family history as one of the most important buck selection criteria. However, breeders of crossbred goats were more interested than breeders of other breeds in both of these selection criteria (60% and 67%,

respectively). Shami goat breeders were second for the dam merit criterion (53%), while Ardi (42%) and Shami (40%) goat breeders were second for dam twinning ability.

Finally, only 20% and 17% of the goat breeders chose buck testicular size and buck source, respectively, as selection criteria for their replacement bucks. Similarly, breeders of crossbred goats were the most interested in these two selection criteria, and second were the Jamodi goat breeders for the first criterion and the Shami breeders for the second criterion (Table 4).

Factors influencing selection criteria of bucks

All factors that influenced doe selection criteria also influenced buck selection criteria (Table 6). The breed of goat significantly influenced seven of the buck selection criteria. The influence of breed on breeders' decisions regarding buck selection criteria was stated by others [23]. Body morphology and breed purity, the two subjective criteria, were only significantly influenced by the breed of goat. Breeders of Pakistani goats were 7.38 times more concerned about body morphology than breeders of Other breeds, while breeders of Shami and crossbred goats were 6.13 and 5.55 times, respectively, more concerned than breeders of Other breeds (Table 6). Breed purity was significantly ($P < 0.01$) different among breeds; the ORs were 2.08 for Boer goats and 1.73 for Jamodi, while Local and Omani goats had ORs of 0.10 and 0.27, respectively. Crossbred goats' breeders were more cautious about the disease resistance criteria with an OR of 4.47 and about kidding ease with an OR of 8.30. The buck dams' merit was significantly ($P < 0.05$) influenced by goat breed, with ORs ranging from 0.42 for Local goats to 2.75 for crossbred goats. Similarly, the dams' twinning ability was significantly ($P < 0.01$) affected by goat breed, with ORs ranging from 0.53 for Local goats to 8.79 for crossbred goats. Pakistani goat breeders were not concerned with buck source as a selection criterion, with an OR of 0.00, while crossbred breeders had an OR of 5.43.

The region of the farm significantly influenced 5 buck selection criteria (Table 6). Al-Dhafra breeders were extremely more concerned about buck fertility, disease resistance, mortality rates, and kidding ease than breeders of the other two regions. Abu-Dhabi and Al-Ain breeders were more concerned with the buck being one of twins, with ORs of 2.50 and 1.02, respectively. Similarly, breeders in different districts in Ethiopia were reported to have different decisions on buck selection criteria [24].

Breed	N	GR	BM	FR	BT	BP	DR	MR	KE	DM	DT	TS	BS
P-value		0.146	0.0911	0.0135	0.099	<0.0001	0.0035	0.013	0.0007	0.0232	<0.0001	0.1503	0.0031
Ardi	57	83	77	74	51	58	60	51	47	23	42	21	28
Boer	10	100	70	70	80	90	60	50	40	30	20	10	10
Crossbred	15	100	93	67	80	67	67	67	87	60	67	47	40
Jamodi	7	71	86	43	57	86	29	29	14	29	29	43	14
Local	107	77	66	41	46	24	34	35	28	19	10	19	8
Omani	16	81	75	56	38	44	6	0	13	38	31	6	25
Pakistani	20	90	95	45	50	60	40	30	30	25	20	10	0
Salali	27	67	78	67	59	70	41	41	41	30	30	22	22
Shami	15	67	93	53	67	67	47	40	33	53	40	27	33
Others	17	82	77	53	35	77	41	41	41	35	18	18	12
Overall Average	291	80	76	55	52	50	42	39	36	28	26	20	17

Table 5. Proportions of breeders selecting buck selection criteria for the different goat breeds in Abu-Dhabi Emirate.

GR: Growth rate, BM: Body morphology, FR: Fertility, BT: Being twin, BP: Breed purity, DR: Disease resistance, MR: Mortality, KE: Kidding ease, DM: Dams merit, DT: Dam twinning ability, TS: Testicle size, BS: Buck source. Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi and Somali.

Property type significantly influenced only 3 buck selection criteria (Table 6). Odds ratios reveal that breeders who own registered farms are more concerned with a buck being one of twins than breeders of the other farm types, while breeders of the random farms and mixed farming were more worried about testicular size and buck source selection criteria. Registered farm owners might have received a higher level of support from the government; therefore, they are less concerned with the fitness characteristics of their bucks. Likewise, researchers have highlighted the importance of production systems on breeders'

decisions regarding selection criteria, especially those related to fitness traits [21][23]. Herd type significantly ($P < 0.05$) influenced only buck dam twinning ability, with breeders of mixed herds of both small ruminants being more concerned with dam twinning ability than breeders of pure herds (Table 6). Breeders of medium (151 – 350 heads) and small (<151 heads) sized herds were significantly ($P < 0.05$) less concerned about replacement buck fertility than those of large herds (>350 heads), with odds ratios of 0.49 and 0.42, respectively.

Conclusion

Breeders in Abu-Dhabi Emirate do not have predetermined breeding objectives in order to improve their bucks and does according to defined selection criteria. Breeders need to accurately predefine their breeding objectives to improve the performance of their animals. Therefore, an essential extension strategy is needed to raise breeders' understanding and provide them with practical guidance toward a genetic improvement program that satisfies their needs and improves their animals' productivity.

Goats in Abu-Dhabi Emirate are raised for multiple purposes; however, increasing meat production was the main breeding objective. Though, a successful breeding program needs to formulate different selection criteria for bucks and does, considering differences in breeds, regions, property types, and herd sizes.

Factor	BM	FR	BT	BP	DR	MR	KE	DM	DT	TS	BS
Breed P-value	0.0415			<0.0001	0.033		0.0036	0.0232	<0.0001		0.0031
Ardi vs. Others	2.08			0.44	2.07		0.70	0.54	3.21		3.60
Boer vs. Others	1.20			2.75	1.45		0.59	0.79	1.19		0.85
Crossbred vs. Others	5.55			0.66	4.47		8.30	2.75	8.79		5.43
Jamodi vs. Others	2.22			1.74	0.39		0.20	0.73	2.08		1.05
Local vs. Others	0.61			0.10	0.73		0.54	0.42	0.53		0.67
Omani vs. Others	0.97			0.27	0.08		0.19	1.10	1.86		2.99
Pakistani vs. Others	7.38			0.48	1.43		0.51	0.61	1.10		0.00
Salali vs. Others	1.71			0.71	0.89		0.65	0.77	2.07		1.97
Shami vs. Others	6.13			0.60	1.48		0.55	2.10	3.25		4.30
Region P-value		0.001	0.0291		<0.0001	<0.0001	0.0001				
Abu-Dhabi vs. Al-Dhafra		0.42	2.50		0.06	0.17	0.38				
Al-Ain vs. Al-Dhafra		0.31	1.02		0.25	0.20	0.27				
Property type P-value			<0.0001							0.0061	0.0305
Random vs. Registered animal farm			0.40							8.31	4.99
Mixed farming vs. Registered animal farm			0.78							5.57	3.45
Herd type P-value									0.0497		
Pure goat vs. Mixed									0.37		

doi.org/10.32388/WWA5M9.2

Factor	BM	FR	BT	BP	DR	MR	KE	DM	DT	TS	BS
Herd size P-value		0.0139									
Small =< 150 vs. Large > 350 heads		0.49									
Medium 151 - 350 vs. Large > 350 heads		0.42									

Table 6. Factors influencing selection of buck selection criteria for goat breeds in Abu-Dhabi Emirate.

BM: Body morphology, FR: Fertility, BT: Being twin, BP: Breed purity, DR: Disease resistance, MR: Mortality, KE: Kidding ease, DM: Dams merit, DT: Dam twinning ability, TS: Testicle size, BS: Buck source. Others: African, Haw, Hawarez, Jabali, Maltese, Saanen, Zafari, Saedi, Rahbi, and Somali.

Statements and Declarations

Ethics

The study involving human participants (goat breeders) was conducted in accordance with the Declaration of Helsinki. Ethical review and approval were obtained from the Deanship of Scientific Research - the University of Jordan Institutional Review Board (Approval No. 2024-007). Written informed consent was obtained from all participants involved in the study prior to the interview.

Data Availability

The data presented in this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy restrictions related to the survey participants.

Author Contributions

Conceptualization, M.J.T.; methodology, M.J.T., M.M.B., F.S.B.; software, M.J.T.; validation, M.J.T., M.M.B., F.S.B.; formal analysis, M.J.T.; investigation, M.M.B., F.S.B.; resources, M.J.T.; data curation, M.J.T., M.M.B.; writing—original draft preparation, M.J.T.; writing—review and editing, M.J.T., M.M.B., F.S.B.; visualization,

M.J.T.; supervision, M.J.T.; project administration, M.J.T. All authors contributed to the interpretation of the results.

Acknowledgements

The researchers are extremely grateful to the Abu-Dhabi Agriculture and Food Safety Authority, Abu-Dhabi, UAE, for the financial support and to the persons who assisted in performing this study.

References

1. ^*Food and Agriculture Organization Statistics (FAOSTAT) (2014). "Food and Agriculture Organization Statisti cs." Food and Agriculture Organization Statistics (FAOSTAT).*
2. ^*Food and Agriculture Organization (FAO) (2015). "The Second Report on the State of the World's Animal Gen etic Resources for Food and Agriculture." FAO Commission on Genetic Resources for Food and Agriculture Ass essments. Rome, Italy.*
3. ^*Abu-Dhabi Food Control Authority (ADFCA) (2016). "Statistics Book." Abu-Dhabi Food Control Authority (A DFCA). Abu-Dhabi Emirate, UAE.*
4. ^*Sherif S, Al-Shorepy S, Al-Juboori A, Fathelrahman E (2014). "Sustainability of Sheep and Goat Production Sy stems under United Arab Emirates' Arid land Constraints." APCBEE Procedia. **8**:236–241.*
5. a, b, c, d, e, f, g, h, i*Tabbaa MJ, Al-Atiyat R (2009). "Breeding objectives, selection criteria and factors influencing them for goat breeds in Jordan." Small Rumin. Res. **8**(4):8–15.*
6. a, b*Tabbaa MJ, Barakeh FS, Baker MM (2019). "Factors influencing farmers decision on breeding objectives an d selection criteria for sheep breeds in Abu Dhabi Emirate, UAE." Bulgarian Journal of Agricultural Science. **25** (1):141–152.*
7. ^*Byrne TJ, Amer PR, Fennessy PF, Hansen P, Wickham BW (2012). "A preference-based approach to deriving b reeding objectives: applied to sheep breeding." Animal. **6**(5):778–788.*
8. ^*Kahi AK, Rewe TO, Kosgey IS (2005). "Sustainable community-based organizations for the genetic improve ment of livestock in developing countries." Outlook Agric. **34**:261–270.*
9. ^*Wurzinger M, Sölkner J, Iñiguez L (2011). "Important aspects and limitations in considering community-bas ed breeding programs for low-input smallholder livestock systems." Small Rumin. Res. **98**:170–175.*
10. ^*Olesen I, Navrud S, Kolstad K (2006). "Economic values of animal welfare in breeding goals." Proceedings of the 8th World Congress on Genetics Applied to Livestock Production. Belo Horizonte, Minas Gerais, Brazil. CD -ROM communication, 31-07.*

11. ^Solkner J, Grausgruber H, Okeyo A, Ruckenbauer P, Wurzinger M (2008). "Breeding objectives and the relative importance of traits in plant and animal breeding: a comparative review." Euphytica. **161**:273–282.
12. ^Caussade S, Ortuzar Jd D, Rizzi LI, Hensher DA (2005). "Assessing the influence of design dimensions on stated choice experiment estimates." Transportation Research Part B: Methodological. **39**:621–640.
13. ^Tano K, Kamuanga M, Faminow MD, Swallow B (2003). "Using conjoint analysis to estimate farmer's preferences for cattle traits in West Africa." Ecological Economics. **45**:393–407.
14. ^Nielsen H, Olesen I, Navrud S, Kolstad K, Amer P (2011). "How to consider the value of farm animals in breeding goals: a review of current status and future challenges." Journal of Agricultural and Environmental Ethics. **24**:309–330.
15. ^Wolfova M, Wolf J, Přibyl J, Zahradkova R, Kica J (2005). "Breeding objectives for beef cattle used in different production systems: 1. Model development." Livestock Production Science. **95**:201–215.
16. ^Mokantla E, McCrindle CM, Sebei JP, Owen R (2004). "An investigation into the causes of low calving percentage in communally grazed cattle in Jericho, Northwest Province R." Journal of South African Veterinary Association. **75**:30–36.
17. ^Abu-Dhabi Food Control Authority (ADFCA) (2013). "Statistics Book." Abu-Dhabi Food Control Authority (ADFCA). Abu-Dhabi Emirate, UAE.
18. ^Tabbaa MJ, Hassanin HH (2017). "Production systems of village chickens in the Abu-Dhabi Emirate, UAE." African Journal of Agricultural Research. **12**(40):2986–2994.
19. a, bSAS Institute (2009). "SAS User Guide. LOGESTIC Procedure." Cary, NC, USA.
20. a, bNandolo W, Wurzinger M, Meszaros G, Van Tassell C, Gondwe T, Mulindwa H, Lamuno D, Solkner J (2016). "Identification of breeding objectives in community-based goat breeding programmes in Malawi." Acta Agriculturae Slovenica, Supplement. **5**:103–108.
21. a, b, c, d, e, f, g, h, iAhmed S, Kefelegne K, Kefena E (2015). "Breeding objective, selection criteria and breeding practice of indigenous goats in western Ethiopia: Implications for sustainable genetic improvement." Greener Journal of Agricultural Sciences. **5**(5):167–176. doi:10.15580/GJAS.2015.5.072715105.
22. a, b, c, d, e, fAbraham H, Gizaw S, Urge M (2017). "Begait Goat Production Systems and Breeding Practices in Western Tigray, North Ethiopia." Open Journal of Animal Sciences. **7**:198–212.
23. a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, qKebede T, Haile A, Dadi H (2012). "Smallholder goat breeding and flock management practices in the central rift valley of Ethiopia." Trop Anim Health Prod. **44**:999–1006.
24. a, b, c, d, e, f, g, h, i, j, kAsefa B, Kebede K, Effa K (2015). "Breeding objective, selection criteria and breeding system of indigenous goats types in Bale Zone, Oromia Ethiopia." J. Agril. Res. Innov. Tech. **5**(2):7–15.

25. ^a, ^b*Lopes FB, Borjas AR, Silvaa MC, Facó O, Lôbo R, Fiorvanti MCS, McManus C (2012). "Breeding goals and selection criteria for intensive and semi-intensive dairy goat system in Brazil." Small Rumin. Res.* ***106****:110–117.*

26. ^*Rose IJ (2014). Breeding strategies to make sheep farms resilient to uncertainty. PhD thesis. Wageningen University, Wageningen, NL. 188 p.*

27. ^*Santos BFS, McHugh N, Byrne TJ, Berry DP, Amer PR (2015). "Comparison of breeding objectives across countries with application to sheep indexes in New Zealand and Ireland." J. Anim. Breed. Genet.* ***132****:144–154.*

28. ^a, ^b*Lopes FB, Silvaa MC, Miyagi ES, Fioravanti MCS, Facó O, Lôbo R, McManus C (2013). "Comparison of selection indexes for dairy goats in the tropics." Acta Scientiarum. Animal Sciences. Maringá.* ***35****(3):321–328.*

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.