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

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Abstract

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 Abu-Dhabi Emirate to explore their breeding objectives and selection criteria. A total of 293 different goat breeds herds with a total of 49911 heads of goats were investigated. The results suggest that goat breeders in UAE are breeding goats mainly for meat production (94%), adaptability to environment (40%), and disease resistance (35%). Only few breeders considered milk production (21%) as breeding objective. Factors influenced breeders' decision on breeding objectives were 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, twining ability and body morphology selection criteria were considered the most important on the 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 was growth rate (80%) and body morphology selection criterion (76%) then fertility, buck being one of twins and breed purity with averages in 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.

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Highlights

- The main breeding objectives 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 manufacturing systems. As a result, there are over 576 breeds available worldwide, and their population is growing [1][2]. Goats' population in United Arab Emirates also increasing; according to Statistics Book [3] there were more than 1.3 million head of goats in Abu-Dhabi Emirate, and represents more than 37% of the overall animal heads in the Emirate. Although, raising goat 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 as hoppy and as a source of milk and meat mainly used for family consumption. Breeders select breed based on its morphostructural and production characteristics. Maintaining biodiversity among breeds requires distinctive breeding objectives for each breed. However, breeders are often concentrating on morphostructural 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 (unpublished data). However, there is no an animal breeding program for improving goats and data is lacking on breeder's belief on breeding objectives of the different goat breeds they own.

The traditional method for determining breeding objectives is by using mathematical equations related to profit take into account cost and returns constituents to derive economic weights that to quantify the genetic change [7]. However, definitions of breeding objectives through research may not be adopted in reality if they did not reveal the belief of the breeders. The failure of many breeding programs aiming at genetically improve livestock breeds was mainly due to absence of breeders' opinion 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 to environment that could affect breeders' decision despite the fact being not easy to be defined [10][11]. Recently, other approaches were used to derive breeding objectives for animal improvement programs as

to use 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 relations to their belief in the paybacks which might be achieved through genetic improvement [13][14]. Many factors could affect the breeders' choice of breeding objectives and selection criteria, this includes 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 type of farming where breeders are aiming for high fertility [16]. In United Arab Emirates, no studies were 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 UAE. This will be valuable to breeders to improve productivity of their animals and to provide 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 examine the potential factors might affect their decisions.

Material and Methods

Study area

The study was conducted in the three regions of Abu-Dhabi Emirate the Abu-Dhabi, Al-Dhafra and Al-Ain with their sub-regions between December 2015 and September 2016. The Emirate is found 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. 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 based on interviewing 5 breeders per one percent of 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 49911 heads of goats.

The government do not allow breeders to graze their animals outside their properties. Three property types are found: random and registered animal farms, and mixed farms of animal 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 a random places and they were not registered. Both animal farms (registered and random) were allowed to raise only various species of animals but not to grow crops or trees while mixed farms and are allowed to grow crops, vegetables and trees and raise animals. Two types of herds were found one of which pure goat or mixed with sheep. If number of adults were up to 150 heads, herds were categorized as small, if number of adults were between 151 to 350 heads, herds were categorized as medium and large herds with adult

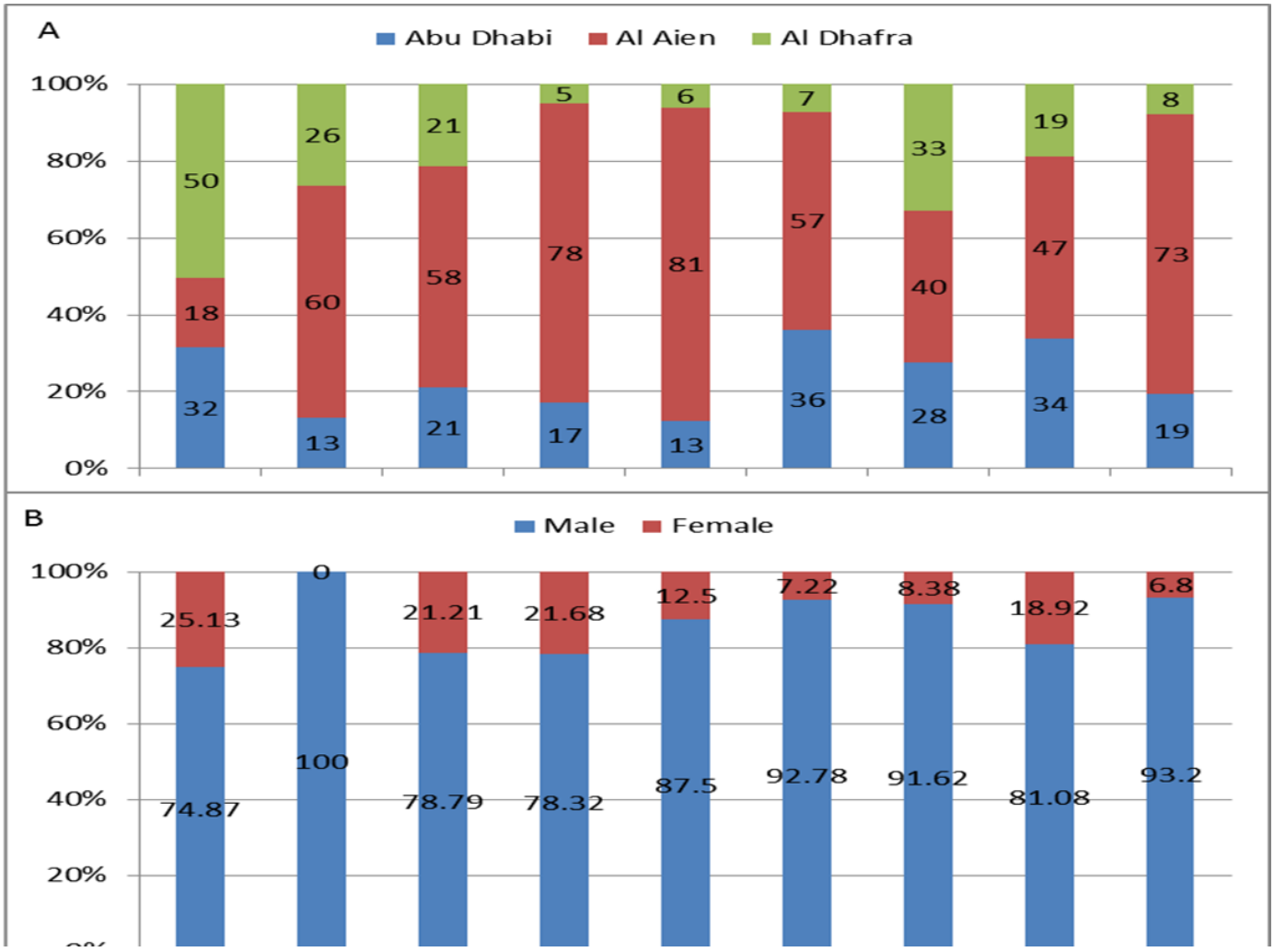
animals were more than 350 heads.

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 about their replacement does and bucks, and if they were homegrown or brought from other herds. The questionnaire also included additional information with relative 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 was statistical analyzed using the Chi-square test of the FREQ procedure[19]. In the initial statistical analysis owner gender was assumed as a factor; however, no one criteria was affected by gender (Figure 1B). After that, stepwise logistic regression was applied using LOGIST procedure [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.



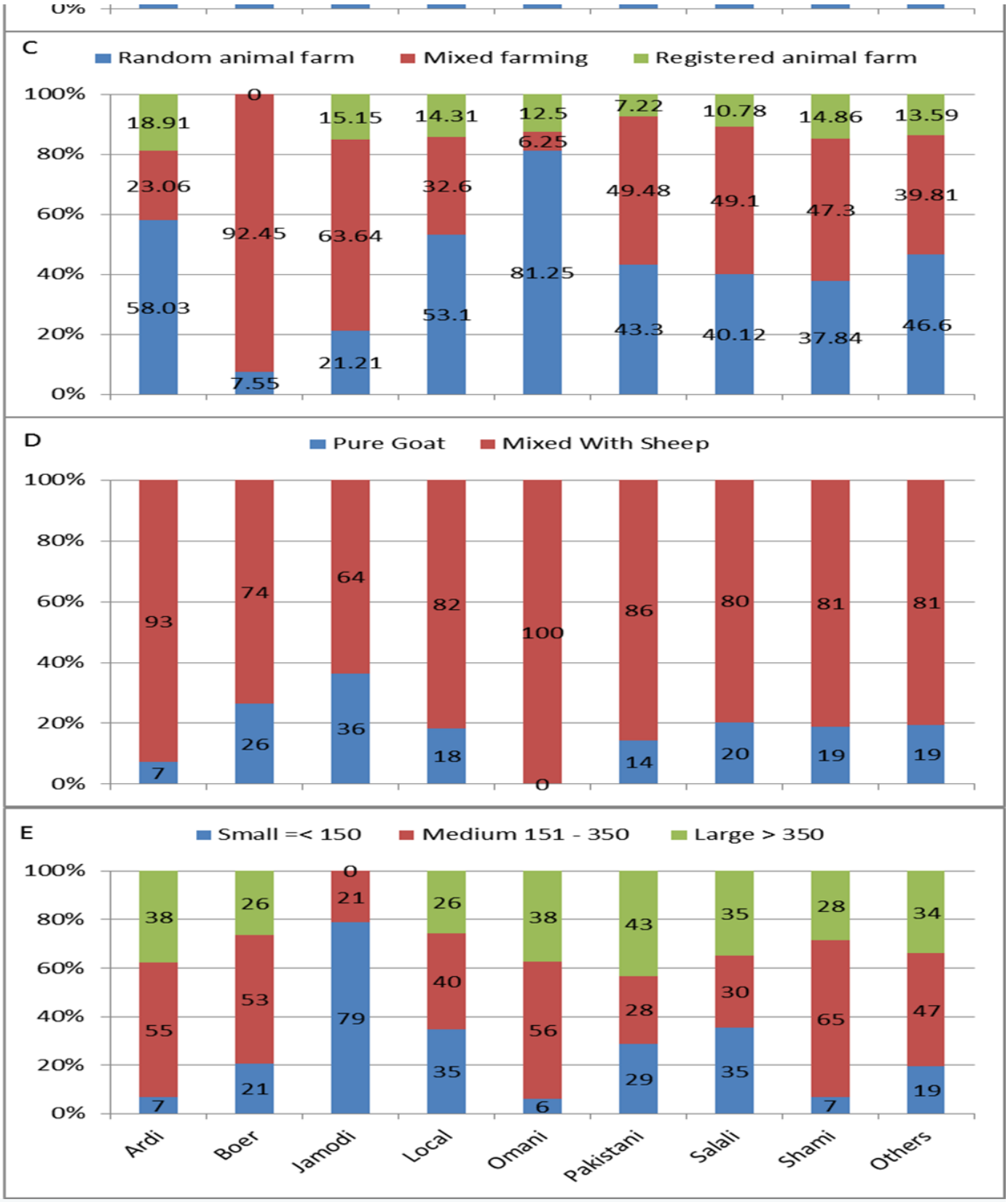


Figure 1. Distribution of goat breeds in different A) regions, B) gender ownerships, C) property types and D) herd types and E) sizes in the Abu-Dhabi Emirate, UAE.

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 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 was cash income from sale of live goats and in second place by meat and milk production for home consumption [21][22]. Goat meat is preferred by many local people of the UAE with growing demand for it in the market of the Gulf States [21]. Other researchers reported multiple breeding objectives chosen by breeders to improve 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 breeding objectives for their goats.

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

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

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 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 environmental conditions (50 – 56%) than those raising local breed (36%) or breeds of adjacent countries such as Omani (14%); which is a justifiable decision, since the later 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 environment, disease resistance was more considered by breeders of exotic breeds. Though, more pronounced, and 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 only considered by 21% of the breeders as a breeding objective (Table 1). This is because most breeders of 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 considered milk production as the main breeding objective for goat keeping [5][24]. In Brazil and other industrial countries, breeders consider not only milk yield but also milk quality [25]. Anyway, goat improvement strategy should consider breeders breeding objectives and their traditional breeding practices [23]. Although, milk production as 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%. Though, 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 discovered among breeders of different goat breeds. More of Boer goats 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 in the shows of livestock in the Emirate and judged on their unique morphological characteristics. Breeders in Jordan emphasized more the unique morphological characteristics to each breed as it was the second most important breeding objective with 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 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 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' decision on breeding objectives was different due to breed raised [23]. Breed of goat significantly influenced breeders' decision on disease resistance, milk production and breed unique morphology. The odds ratio (OR) revealed that the breeders of Shami and Omani goats were worried the least with disease resistance then the breeders of Jamodi and Salali goats and then by the other breeders. This could be due to that these breeds were more

resistant to diseases than other breeds raised under the UAE conditions. Regarding breeding objective of milk production, the breeders were concerned the most were crossbred, Shami and Ardi goats' breeders and the least concerned breeders were those raising Jamodi followed by Local goats' breeders. Ardi goats' breeders were the most worried about breed unique morphology then Boer goats' breeders and then by breeders of Shami and Salali goats.

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

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

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.

Region of Abu-Dhabi Emirate has a highly significant ($P < 0.01$) influence on the breeders' breeding objectives toward adaptability to environment, disease resistance, and unique morphology of the breed (Table 2). Likewise, breeders in other countries had different breeding objectives in different regions as some concern more with economical traits like meat, milk, and cash income and disease resistant and others emphasis more the breed unique morphology [24][26]. The influence of region on breeders' decisions on breeding objectives may reflect differences due to ecological, social factors, economic and marketing opportunity available in different regions [25]. Breeders in Al-Dhafra region were extremely more worried about adaptability to environment and disease resistance than breeders in both Al-Ain and Abu-Dhabi regions and

those of Al-Ain were more worried than those in Abu-Dhabi. In general, Al-Dhafra region has harsher environmental conditions than the other two regions and more facilities like fresh water and clinics available for breeders in these two regions than that for breeders of Al-Dhafra region. Similarly, the breeders of Al-Ain region were more likely to select goats for breed unique morphology than those of the other regions of the Emirate, though the differences in OR (19.50) were higher than 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 goats' population is in Al-Ain region. However, more than 50% of Ardi goats were found in 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 objectives 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 possible 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% only found 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 diseases resistance ($P = 0.01$) and breed unique morphology ($P < 0.05$) with small herds being the most in both characteristics (Table 2). This indicated 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 were significantly different ($P < 0.01$, Figure 1E), with medium sized herds has more than 42% of all 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%) was among the most important, the second (breed purity 40%) was in the middle and the third (doe sources 18%) was the least important by 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 suggest that breeders are selecting their animals on two-stage procedure; first use body morphology and family history in early stage of life then use production and reproduction characteristics at later stage [21]. Fertility, twining ability, body morphology and growth rate selection criteria were considered the most important on average by goat breeders in Abu-Dhabi Emirate with a medium proportion of breeders choosing them (60% – 65%). Fertility traits, twining ability and growth rate were among the most important selection criteria reported by several researchers [22][23]. Fertile does that produce twins with high rate of kidding are favored by the breeders because they contribute more to their income [23]. However, some breeders revealed that twining 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 improvement of meat and milk productivity and longevity traits [5][23][24]. Tabbaa and Al-Atiyat [5] found that goat breeders in Jordan were the most concerned with doe source as a selection criterion for their replacement does. Fertility and twining 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 they were 80%. This might signify the importance of these criteria for crossbreeding goats. High proportion of breeders considered growth rate criteria for Ardi, Pakistani and Omani goat. 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 in (40 - 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 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 for 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 criteria 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, measurement ease 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].

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

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

FR: Fertility, TA: Twining ability, GR: Growth rate, BM: Body morphology, DR: Disease resistance, AM: Average merit, KE: Kidding ease, BP: Breed purity, LS: Last season productivity, DM: Dams 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' decision on selection criteria toward body morphology, kidding ease, breed purity, last season productivity, dam's merit, and doe source (Table 4). Differences in breeders' decision 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 odds ratio shows (2.49), and followed by Boer (1.39), other breeders then followed. The odds ratio revealed also 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 comes next in kidding ease, Jamodi goats' breeders comes next in last season productivity, Shami goat breeders comes second in dam merit and Ardi goat breeders comes 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 comes next (Table 4).

The region where the farm is located significantly influenced several doe selection criteria included 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' decision on selection criteria in different regions of the same country. Region differences may reflect environmental condition differences or differences in marketing opportunity [24][28]. Therefore, in order to have a successful breeding program different selection criteria and selection strategy need to be adopted in different regions even for the same breeding objectives [20]. As the odds ratio revealed, breeders of Abu-Dhabi

region were the most worried 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 UAE, significantly influenced the breeders' decision on doe selection criteria toward twining ability, growth rate, body morphology and disease resistance (Table 4). Production system was reported to influence breeders' decision on selection criteria [23]. Breeders of the registered farms were the most worried about twining 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 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 productivity (Table 4). The odds ratio revealed that pure goat breeders were concentrating more on last season productivity (3.22) and less on growth rate (0.38). On the other hand, herd size significantly influenced fertility, breed purity and last season productivity (Table 4). Breeders of the small herd size were concentrating on fertility and breed purity while large herd breeders were more concerned with last season productivity.

Selection criteria of bucks

Decisions on replacements 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 that for doe (Table 3). Similarly, breeders in Ethiopia slightly put more pressure on morphological characteristics for replacement buck selection than that for doe selection criteria [23]. However, Jordanian breeders put more pressure on bucks' objective selection criteria than that 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, 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.

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

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		

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

Body morphology selection criterion (76%) was the second in importance for the breeders after growth rate with also, 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 goat, though, the value for Shami and crossbred breeders was 93%.

Fertility, buck being one of twins and breed purity came in the third place as selection criteria with averages in 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 significant difference ($P < 0.05$) among different breeds while buck being one of twins was considered most by breeders of Boer and crossbred (80%) then by breeders of Shami (67%) with 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 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 twining 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 interested more than breeders of other breeds on both of these selection criteria (60% and 67%, respectively). Shami goat breeders were second for the dam merit criteria (53%) while Ardi (42%) and Shami (40%) goat breeders were second for dam twining 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 was 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 influenced doe selection criteria had also influenced buck selection criteria (Table 6). The breed of goat significantly influenced seven of the buck selection criteria. Influence of breed on breeders' decisions on buck selection criteria was stated by others [23]. Body morphology and breed purity, the two subjective criteria, were only significantly influenced by breed of goat. Breeders of Pakistani goats were 7.38 times more worried about body morphology than breeders of Others breeds, while breeders of Shami and crossbred goats were 6.13 and 5.55 times, respectively, more concerned than breeders of Others 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 ORs were 0.10 and 0.27, respectively. Crossbred goats' breeders were more cautious about disease resistance criteria with OR of 4.47 and about kidding ease with OR of 8.30. Buck dams' merit was significantly ($P < 0.05$) influenced by goat breed with OR ranged from 0.42 for Local goats to 2.75 for crossbred goats. Similarly, dams twining ability was significantly ($P < 0.01$) affected by goat breed with OR ranged 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 OR of 0.00, while crossbred breeders OR was 5.43.

Region of 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 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].

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

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

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 twining 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 in buck being one of twins than breeders of the other farms 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 higher level of support from the government therefore they are less concerned with fitness characteristics of their bucks. Likewise, researchers have highlighted the importance of production systems on breeders' decision on selection criteria, especially those related to fitness traits [21][23]. Herd type significantly ($P < 0.05$) influenced only buck dam twining ability with breeders of mixed herds of both small ruminants were more concerned with dam twining 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 of Abu-Dhabi Emirate do not have predetermined breeding objective in order to improve their bucks and does according to defined selection criteria. Breeders need to predefine accurately their breeding objectives to improve

performance of their animals. Therefore, an essential extension strategy is needed to raise breeders' understanding and provide them with practical guidance toward genetic improvement program that satisfy their needs and improve 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.

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

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		
Herd size P-value		0.0139									
Small =< 150 vs. Large > 350 heads		0.49									
Medium 151 - 350 vs. Large > 350 heads		0.42									

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

Statements and Declarations

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