Bulgarian Journal of Agricultural Science, 25 (No 1) 2019, 141–152

Factors influencing farmers decision on breeding objectives and selection criteria for sheep breeds in Abu Dhabi Emirate, UAE

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Abstract

Tabbaa, M. J., Barakeh, F. S., & Baker, M. M. (2019). Factors influencing farmers decision on breeding objectives and selection criteria for sheep breeds in Abu Dhabi Emirate, UAE. *Bulgarian Journal of Agricultural Science*, *25*(1), 141–152

Farmers' participation in defining breeding objective and selection criteria is necessary for successful application of breeding programs. A questionnaire was prepared and tested, and a survey was conducted in order to obtain farmers opinions on breeding objective and selection criteria that could be adopted for different sheep breeds in Abu Dhabi Emirate (UAE) and understand the factor influence farmers' opinion. The main breeding objectives were meat production (97%), disease resistance (39%) and adaptability to environment (37%). Fewer farmers considered breed unique morphology (20%), milk production (10%) and fiber production (2%). Breed of sheep, region, property type and flock type and size significantly influenced farmers' opinion on breeding objectives except for meat and milk production which were not influenced by any of these factors. Multiple selection criteria were chosen by sheep farmers of the UAE for replacement ewes, with only three out of twelve were subjective while the rest were objective criteria. Growth rate, twining ability, fertility and body morphology were the most important ewes' selection criteria considered by the sheep farmers (63-76%). Similar to ewes, twelve multiple selection criteria were chosen for ram improvement, though, more subjective selection criteria were emphasized on rams than that on ewes and more significant differences were found among the different ram breeds of sheep. Growth rate (86%) and body morphology (82%) were the most important rams' selection criteria. Differences in adoption selection criteria due to breed, region and production system including property type, flock size and type need to be considered in order to achieve maximum possible genetic improvement out of a sustainable breeding program for sheep in UAE.

Keywords: sheep breeding; genetic improvement; selection; farmer survey; Arab peninsula

Introduction

Sheep is the most popular and common livestock in the United Arab Emirate (UAE) with a population exceeds 1.7 million heads in Abu-Dhabi Emirate alone which represents more than 50% of the total animal heads in the Emirate (ADFCA, 2016). This total number of sheep consists of several breeds. Sherif et al. (2014) studied the sustainability of sheep production systems under UAE and concluded that inefficiency of inputs utilization where all inputs used in production were over utilized. This is might be due to that most farmers in the UAE do not consider sheep as an income source rather it is part of their heritage and as a source of meat for home consumption regardless of the flock size. In

general, breeders select each breed taking into consideration its unique morphology characteristics as good indicators for high productivity. This selection practices by breeders is known as subjective selection could be performed sometimes as it was applied by sheep farmers of New Zealand to improve wool and lambing performance (Gavigan and Parker, 1997). To initiate a breeding program for genetic improvement of sheep productivity, information is needed about breeder's conception of the breeding objectives of their sheep breeds. However, in UAE, no studies yet have been found so far stating the selection criteria used by the Emirates breeders to achieve their breeding objectives.

Determining breeding objectives based on objective selection criteria rather than subjective selection criteria and using profit equations with economic weights that take into account cost and returns components of each character to achieve genetic improvement is a well known and right procedure (Byrne et al., 2012a). However, farmers might not adopt these objectives if they did not satisfy in practice their perceptions of genetic improvement of their animals (Dekkers and Gibson, 1998). In addition, these economic weights sometimes are unable to reflect the value of subjective traits that might add to the farmers' profit under some production systems, such as traits related to animal welfare and/or environmental impact which may affect breeders' selection even though being difficult to define (Olesen et al., 2006; Solkner et al., 2008; Nielsen et al., 2011). Therefore, researchers came up with other procedures to derive breeding objectives and selection criteria for animal improvement using breeders' preference techniques where questionnaires are prepared, and breeders are asked to choose in multiple-answers questions (Caussade et al., 2005). The related analysis is applied then to breeders' preferences to determine their perception of breeding objectives and selection criteria for their animals to achieve anticipated genetic improvement (Tano et al., 2003; Tabbaa and Al-Atiyat, 2009). The farmers' decision of breeding objectives and selection criteria could be affected by breed, production system and herd size (Jabbar et al., 1998; Wolfova et al., 2005). Duguma et al. (2010) identified several factors that influence farmer breeding objectives and selection criteria.

This study is a significant attempt to understand the breeders' needs from their sheep genetic resources in United Arab Emirates, which will be beneficial through the improvement of their animals' productivity and providing a practical guidance toward genetic improvement program. Therefore, the research work aimed to investigate the breeding objectives and selection criteria adopted by farmers of different sheep breeds and find out the factors that potentially affected farmer' decisions on these breeding objectives.

Materials and Methods

Selection of the survey area

A survey was accomplished between December 2015 and September 2016 in Abu-Dhabi Emirate covering its three regions (municipalities); Abu-Dhabi, Al-Ain and Al-Dhafra and sub-regions. Abu-Dhabi Emirate is located between 22°40" and 25°N and 51° and 56°E and characterized with hot desert climate, low rainfall, and mostly clear skies all-year-round. Average maximum annual temperature is above 39°C with high humidity during the period from June to September, while cooler temperature (19°C) are experienced from November to March.

Sampling procedure

Researchers interviewed 272 sheep breeders randomly selected according to a stratified random sampling procedure from all regions of the Emirate depending on sheep population in each sub-region (ADFCA, 2013). Sample size was determined based on having 5 breeders for each one percentage of sheep population, with a minimum of 3 breeders in a sub-region. The interviewed breeders own a total of 377 flocks of different sheep breeds with a total of 80401 heads of sheep.

Sheep were not allowed to graze outside the farmers' properties which are of 3 types found in the Emirate: registered animal farms, random animal farms and mixed farms (Tabbaa and Hassanin, 2017). The municipality registered animal farms and mixed farms are established as group by the municipalities and distributed among the local people, while the random animal farms are established in random places, may found in a group or single, and they are unregistered. Both registered and random animal farms are allowed to raise different species of animals but not to grow trees or crops, on the other hand, the mixed farms are allowed to grow trees, crops and vegetables besides raising animals. These farm types may represent the current production systems. Flocks were of two types either pure sheep flocks or mixed with goat and were classified as small if number of adult animals are between 30 to 150 heads, medium if number of adult animals are between 151 to 350 heads and large if number of adult animals are exceeding 350 heads.

Interview procedure

A questionnaire was prepared to gather information related to sheep breeding practices in Abu-Dhabi Emirate. Breeders were explicitly asked about their sheep flock size, breeds owned, breeding objectives, productivity characteristics and selection criteria for each of rams and ewes, and their replacements source if they are originated in the flock

or introduced from other flocks. The questionnaire also included general information related to gender of the owner, the geographical site and location. Infrequent breeds that were found in only one or two farms were grouped together in one group named "Others".

Statistical analysis

Several statistical analyses were performed in a sequence. First of all, survey data was subjected to simple descriptive statistics analysis using the Chi-square test of the FREQ procedure (SAS Institute, 2009). Then, stepwise logistic regression procedure analysis was used to study the effect of the potential factors on breeding objectives and selection criteria of sheep breeds in Abu-Dhabi Emirate. The LOGIST procedure (SAS Institute, 2009) was utilized with a model that includes all factors found to influence farmers' decisions on breeding objectives and selection criteria. Odds ratios (OR) were calculated to approximate the relative importance of the different factors on breeders' decisions.

Results and Discussion

Breeding objectives

Farmers' decisions on breeding objectives of different sheep breeds in Abu-Dhabi Emirate are presented in Table 1. Although, multiple breeding objectives were chosen by sheep farmers in which 97% of them have chosen meat production as the main breeding objective for their sheep. Similarly, the majority of farmers in many countries emphasize meat production from their sheep (Santos et al., 2015; Dagnew et al., 2017). Though, other purposes are also emphasized such as source of income and wealth, especially in the developing countries (Dagnew et al., 2017). Accurately defining breeding objectives is the most crucial step for developing a successful genetic improvement program and determines its direction, since incorrect definition of the objectives would result sometimes in costly collapse of the whole improvement program (Kebede et al., 2012; Lopes et al., 2013; Santos et al., 2015; Nandolo et al., 2016). Though, it is essential that farmers' philosophies are being reflected in their perceptions of breeding objectives to improve specific products and services from their animals (Sölkner et al., 2008; Byrne et al., 2012b). However, significant ($P < 0.05$) differences were found among breeds, and values were ranging from 79-100% of farmers. Orb (sometimes called Arab) is the most common sheep breed in the UAE, and it is small to medium in size (Al-Shorepy, 2003), though, meat production as breeding objective was considered by 100% of its breeders.

The second most important breeding objectives were disease resistance (39%) and adaptability to environmental conditions (37%), with significant differences among breeds and values ranging from 0 to 71% for both breeding objectives. This may reflect hardship faced some farmers when raising exotic breeds in terms of mortality and low productivity of certain breeds. Therefore, those farmers were trying to improve disease resistance and adaptability to environmental conditions in their flocks to overcome these problems. In addition, the recent increase attention environment and animal-welfare by consumers, has made farmers to take in account

Table 1. Proportion of breeders considering breeding objectives for the different sheep breeds

Breed	No.	MP	DR	AE	BU	KP	FP
P-value:		0.013	0.024	0.0071	0.16	0.76	0.97
Awassi	100	98	41	41	23	11	1
Chios	9	100	44	44	11	0	0
Crossbred	18	94	67	67	17	6	6
Hari	6	100	17	17	17	0	0
Indian	6	100	33	17	33	0	0
Jaziri	6	100	67	67	0	0	0
Najdi	153	98	34	31	24	11	4
Orb	41	100	32	34	2	17	2
Pakistani	4	100	50	50	0	0	0
Somali	14	79	71	71	21	14	0
Sudani	8	88	38	50	38	0	0
Habsi	6	100	0	0	0	17	0
Others*	6	100	17	17	17	0	0
Overall average	377	97	39	37	20	10	2

MP: Meat production, DR: Disease resistance, AE: Adaptability to environmente, BU: Breed unique morphology, KP: Milk production, FP: Fiber production
*Others: American, Afghani, South African, Omani and Muflon

characteristics that were not economically important in the past (Olesen et al., 2000; Nielsen et al., 2011). Dagnew et al. (2017) suggested that to achieve success in a breeding program, cultural, social and environmental benefits need to be included in the breeding objectives for sheep production.

Breed unique morphology, milk production and fiber production were the least important breeding objectives, only 20%, 10% and 2%, respectively, of the farmers emphasized these objectives, with no significant ($P > 0.1$) differences among farmers of different breeds.

Factors influencing breeding objectives

Meat and milk production were not significantly affected by any factors, in spite of that meat production was the most important breeding objective and milk was among the least important (Table 1, 2). Other breeding objectives were significantly influenced by breed of sheep, region, property type, flock type and size (Table 2). Kebede et al. (2012) reported that decisions on breeding objectives might be influenced by breed of small ruminant, production system and marketing prospective. Breed of sheep significantly ($P < 0.01$) influenced the farmers' decision on disease resistance and adaptability to environmental conditions as breeding objectives for their sheep. Based on odds ratios result, the farmers of local sheep breeds that are Habsi and Orb were among the least concerned with both breeding objectives and they were similar to Hari and the other breeds (Table 2). This is because that, in one hand, the farmers of other breeds are keeping these breeds just as a hoppy of keeping strange exotic breeds and they are ready to pay the cost of keeping them. On the other hand, local sheep breeds are adapted to the local environmental conditions; therefore, farmers of these breeds are used to the low productivity of these breeds with a good health status. In addition, the local Orb breed is well adapted to a wide range of farming environments of the UAE (Al-Shorepy, 2003). Farmers of the Arab breeds or those used to the harsh environmental conditions such as Hari, Najdi, Sudani and Awassi were in a medium level of concern. However, farmers of exotic breeds such as Pakistani, Indian and Chios breed beside the crossbred farmers were in high level of concern for these two breeding objectives.

Table 2. Factors affecting breeding objectives for sheep breeds and their odd ratios

Factor	DR	AE	BU	FP
Breed *P-value:*	0.0048	0.0054		
Awassi vs Others	2.74	3.17		
Chios vs Others	9.64	8.87		
Crossbred vs Others	23.51	24.00		
Hari vs Others	0.73	0.77		
Indian vs Others	17.52	5.70		
Jaziri vs Others	16.14	15.83		
Najdi vs Others	2.27	2.46		
Orb vs Others	1.42	1.63		
Pakistani vs Others	37.77	33.07		
Somali vs Others	11.04	11.69		
Sudani vs Others	2.23	5.61		
Habsi vs Others	0.00	0.00		
Region *P-value:*	<0.0001	<0.0001	<0.0001	
Abu Dhabi vs Al Dhafra	0.04	0.04	0.90	
Al Ain vs Al Dhafra	0.22	0.17	3.39	
Property type *P-value:*	*0.0072*	0.03		
Random vs Registered animal farm	3.49	2.87		
Mixed farming vs Registered animal farm	2.88	2.95		
Flock Type *P-value*:			<0.0001	
Pure sheep vs Mixed			3.39	
Flock size* *P-value:*			0.0093	0.049
Small vs Large			1.05	4.36
Medium vs Large			0.40	0.88

DR: Disease resistance, AE: Adaptability to environmente, BU: Breed unique morphology, FP: Fiber production

Others: American, Afghani, South African, Omani and Muflon

*Flock size: small < 150, medium 151-350, large > 350 heads

Region highly significantly ($P < 0.001$) influenced the farmers' decisions on breeding objectives on disease resistance, adaptability to environmental conditions and breed unique morphology (Table 2). Similarly, other researchers in several countries reported differences in farmers' decisions on breeding objectives for sheep production due to effect of regions (Lopes et al. 2012; Rose, 2014). These differences could be due to ecological, economic and cultural features of the different regions (Lopes et al., 2013). Since Al-Dhafra region suffer from harsher environmental conditions and lesser availability of facilities like fresh water and farms are distantly distributed from each other which make veterinary clinics further away from each farm in this region relative to the other two regions, farmers of Al-Dhafra region were more concern with those two breeding objectives. It is good to know that 61% of the Somali and 43% of the Jaziri breeds were in Al-Dhafra region (Figure 1A). However, farmers of Al-Ain region were more concerned with breed unique morphology for their sheep breeds than the other two regions. Knowing that, Al-Ain region has 70% of the Najdi and 52% of the Awassi breeds and these two breeds are always exhibited in livestock shows and judged on their breed unique morphology characteristics (Figure 1A).

Farmers of the registered animal farms were less concerned with disease resistance and adaptability to environmental conditions than farmers of the other farm types as the odds ratio

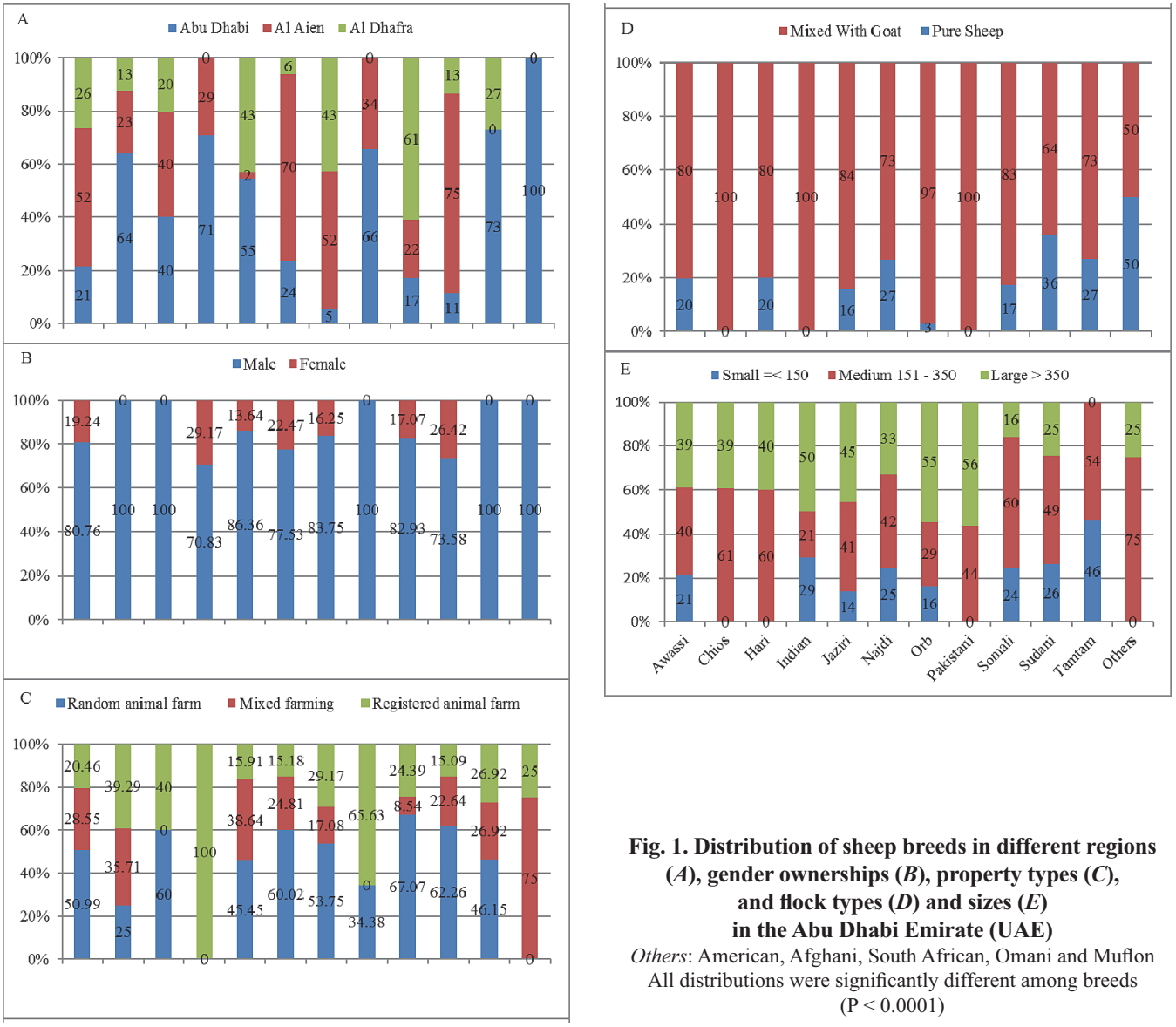

Fig. 1. Distribution of sheep breeds in different regions (*A*), gender ownerships (*B*), property types (*C*), and flock types (*D*) and sizes (*E*) in the Abu Dhabi Emirate (UAE)

Others: American, Afghani, South African, Omani and Muflon
All distributions were significantly different among breeds ($P < 0.0001$)

revealed (Table 2). This result might be due to availability of clean water and veterinary services to this type of farms than the random farms that could be reflected as relative economic efficiencies. Differences in farmers' decisions on breeding objectives were reported by other researchers (Kebede et al., 2012; Santos et al., 2015). In spite of that 100% of the Indian and 65.63% of the Pakistani sheep in Abu-Dhabi Emirate are raised in the registered farms (Figure 1C). In addition, production system usually influences farmers' decisions on breeding objectives due to relative social or economic consequences of certain animal product (Byrne et al., 2012; Dagnew et al., 2017). Flock type highly significantly ($P < 0.001$) influenced the farmers' decision on breed unique morphology for sheep breeds with pure sheep flock owners 3.39 times emphasized this breeding objective more than farmers owned the mixed flocks with goats (Table 2). However, medium flock size owners were less concerned with breed unique morphology (Table 2, Figure 1E), since they are more concerned with production. Small flocks' owners were 4.36 times significantly ($P < 0.05$) more concerned with fiber production than large flocks' owners. It could be due to those small flocks' owners were more interested with handcrafts made of wool than owners of the large flocks. In Ethiopia, the main breeding objective for large flock sheep operation was to obtain cash income and investment opportunity, while that for small flocks was a source of income, meat and wealth (Dagnew et al., 2017).

Selection criteria of replacement ewe

The selection criteria of replacement ewe chosen by farmers who were raising different breeds of sheep in Abu-Dhabi Emirate are presented in Table 3. Multiple replacement ewes' selection criteria were chosen by sheep farmers, with only three out of twelve were subjective criteria while the rest were objective criteria. Other researchers reported that farmers considered both subjective and objective selection criteria for both males and females of small ruminants (Tabbaa and Al-Atiyat, 2009; Asefa et al., 2015). The overall average of farmers choosing the different selection criteria for different breeds of sheep was ranging from 25% to 76%, though, no significant differences due to breed were found except for last season productivity and longevity (Table 3). Last season productivity was chosen by 87% of crossbred sheep farmers while no farmer of Habsi sheep chosen it as a selection criterion for their replacement ewes. In general, both criteria were more chosen by exotic breeds' farmers than farmers of the local or Arab peninsula breeds. However, some numerical differences were observed among the different breeds almost for all other selection criteria. The selection criteria that were emphasized by sheep farmers of Abu-Dhabi Emirate may satisfy the main breeding objective that is the meat production. They would be due to growth rate, twining ability and fertility got the highest emphasis by the farmers. Similarly, for meat production improvement, farmers' decisions on the main selection criteria for females were growth rate, twining ability, body size, milk yield, mothering ability and age at puberty as reported by other researchers in different countries, however, with differences in rating of the most important criterion (Kebede et al., 2012; Ahmed et al., 2015; Santos et al., 2015; Nandolo et al., 2016; Abraham et al., 2017). However, Kebede et al. (2012) reported that dam

Table 3. Proportion of breeders considering replacement ewe selection criteria for the different sheep breeds

Breed	No.	GR	TA	FR	BM	DR	BP	AM	LE	LS	DM	LG	ES
P-value:		*0.23*	*0.24*	*0.51*	*0.30*	*0.24*	*0.11*	*0.16*	*0.38*	*0.0004*	*0.32*	*0.01*	*0.82*
Awassi	102	82	68	62	71	53	58	47	38	34	27	24	28
Chios	7	86	100	71	86	43	43	71	43	43	43	57	43
Crossbred	15	93	100	73	73	67	47	67	73	87	60	60	40
Hari	5	80	80	60	60	40	40	0	20	20	0	20	20
Indian	6	83	67	67	67	33	67	67	33	50	33	50	33
Jaziri	6	100	67	100	33	67	17	0	50	67	17	33	17
Najdi	151	70	64	63	64	52	50	48	36	29	31	28	22
Orb	40	75	68	68	48	40	30	43	50	30	35	13	25
Pakistani	4	50	50	25	75	50	50	25	25	25	25	75	25
Somali	14	79	50	79	57	71	50	43	50	64	21	43	29
Sudani	7	71	71	57	43	57	86	43	57	57	29	29	43
Habsi	5	80	80	40	40	20	80	60	40	0	0	0	0
Others*	5	40	80	40	60	0	60	60	40	60	20	20	20
Overall average	*367*	*76*	*68*	*64*	*63*	*51*	*51*	*47*	*41*	*36*	*30*	*28*	*25*

GR: Growth rate, TA: Twining ability, FR: Fertility, BM: Body morphology, DR: Disease resistance, BP: Breed purity, AM: Average merit, LE: Lambing ease, LS: Last season productivity, DM: Dams merit, LG: Longevity, ES: Ewe source

*Others: American, Afghani, South African, Omani and Muflon

merit was the second most important criteria for female selection after milk yield. In general, farmers choose selection criterion that satisfy their breeding objectives and that are easy for them to measure (Lopes et al., 2012).

Factors influencing selection criteria of replacement ewe

The results of multiple logistic regressions for the farmers' decisions on ewe selection criteria are presented in Table 4. Similar to the simple descriptive statistical results only last season productivity and longevity selection criteria were significantly influenced by breed of sheep raised by the farmers. The odds ratio revealed that farmers of the crossbred sheep emphasized the most the last season productivity while farmers of the local breed of Habsi were not concerned with last season productivity at all. Other local and Arab peninsula breeds were also among the least concerned with this selection criterion in comparison to Others breeds and other exotic breeds. Similarly, longevity was less important for the local breeds' farmers though farmers of were 12.93 times more concerned than Others breeds, farmers of crossbred and Chios sheep were in the second place with 6.37 times and farmers of Indian sheep were in the third with 4.17 times (Table 4).

Region has significantly ($P < 0.01$) influenced the farmers' decision on 8 out of the 12 selection criteria of ewe selected (Table 4). Al-Dhafra sheep farmers were more concerned with fertility, disease resistance, lambing ease, last season productivity and ewe source than farmers of the other two regions, with Al-Ain farmers in the second place of concern. Al-Ain farmers were more concerned with longevity while Abu-Dhabi region farmers were more concerned with growth rate and body morphology than farmers of the other two regions. Although farmers were interested with the

Table 4. Factors affecting replacement ewe selection criteria for sheep breeds and their odd ratios

Factor	GR	TA	FR	BM	DR	BP	AM	LE	LS	DM	LG	ES
Breed *P-value:*									*0.0012*		*0.01*	
Awassi vs Others									0.32		0.91	
Chios vs Others									0.49		6.37	
Crossbred vs Others									6.44		6.37	
Hari vs Others									0.12		0.95	
Indian vs Others									1.04		4.17	
Jaziri vs Others									0.83		2.07	
Najdi vs Others									0.35		1.10	
Orb vs Others									0.18		0.38	
Pakistani vs Others									0.21		12.93	
Somali vs Others									0.99		2.66	
Sudani vs Others									1.23		1.03	
Habsi vs Others									0.00		0.00	
Region *P-value:*	*0.0037*		*0.0031*	*0.0028*	*<0.0001*			*<0.0001*	*<0.0001*		*0.0066*	*0.0009*
Abu Dhabi vs Al Dhafra	1.32		0.34	3.55	0.12			0.09	0.11		0.44	0.23
Al Ain vs Al Dhafra	0.45		0.66	0.75	0.22			0.15	0.18		1.20	0.57
Gender ownership				0.0386					0.003			
Male vs Female				2.20					2.88			
Property type *P-value:*	*<0.0001*	*<0.0001*			*<0.0001*		*0.035*	*0.0034*				
Random vs Registered animal farm	0.16	0.20			3.62		0.94	0.34				
Mixed farming vs Registered animal farm	0.11	0.31			3.33		1.82	0.67				
Flock Type *P-value:*					*0.031*	*0.0032*						*<0.0001*
Pure sheep vs Mixed					1.92	2.32						5.14
Flock size* *P-value*:			*<0.0001*	*0.0017*					*0.0004*	*0.0002*	*0.021*	*0.0086*
Small vs Large			0.87	0.50					0.24	0.37	1.38	0.50
Medium vs Large			0.33	0.33					0.36	0.40	0.57	0.40

GR: Growth rate, TA: Twining ability, FR: Fertility, BM: Body morphology, DR: Disease resistance, BP: Breed purity, AM: Average merit, LE: Lambing ease, LS: Last season productivity, DM: Dams merit, LG: Longevity, ES: Ewe source

Others: American, Afghani, South African, Omani and Muflon

*Flock size: small < 150, medium 151-350, large > 350 heads

same breeding objective different selection criteria or different emphasis were adopted by farmers for different regions. This suggested that different breeding strategies should be applied for different regions to satisfy the farmers' requirements (Nandolo et al., 2016). Though, it should be noticed that 100% of Others breeds, 73% of Habsi, 71% of Indian, 66% of Pakistani and 64% of Chios are raised in Abu-Dhabi region (Figure 1A).

Gender of the farmer has significantly ($P < 0.05$) influenced body morphology as ewe selection criteria, with male farmers being more concerned than female farmers (Table 4). It is more socially accepted that young male farmers attend and being more concerned with the livestock shows than females and, in these shows, animals are judged mainly on their breed unique morphological characteristics. It might be noticed also that the distribution of different breeds is highly significantly ($P < 0.001$) different between the two genders (Figure 1B). Last season productivity was highly significantly ($P < 0.01$) influenced by gender with male farmers being more concerned than female farmers which could be due to that males are more available in the farms and more able to communicate with male workers/employee to judge their animals than females, because of the social and gender restrictions.

Farmers of the registered animal farms were significantly more concerned with growth rate, twining ability and lambing ease of their replacement ewes than farmers of the other two property types as revealed by the odds ratios and that distribution of breed is highly significantly ($P < 0.001$) different among the different property types (Table 4, Figure 1C). Similarly, several researchers reported differences in selection criteria due to differences in production systems (Kebede et al., 2012; Lopes et al., 2012; Santos et al., 2015). However, farmers of the other two property types were significantly ($P < 0.001$) more than three times concerned with their replacement ewes being more disease resistant than farmers of the registered animal farms. Farmers of the mixed farming were significantly ($P < 0.05$) more concerned with average merit of their replacement ewes than farmers of the other two property types. Pure sheep flocks' farmers were significantly more concerned with disease resistance, breed purity and ewe source than farmers with flocks of both sheep and goats (Table 4). Breed distribution was highly significantly ($P < 0.001$) different in the two flock types (Figure 1D). Large flocks' farmers were significantly more concerned with fertility, body morphology, last season productivity, dam merit and their replacement ewe source than farmers of the other two flock sizes while small flock farmers were more concerned with longevity of their replacement ewes (Table 4). It is important to notice that all breeds were found in mixed breeds however distribution of breeds is significantly ($P < 0.001$) different for the two types (Figure 1E).

Selection criteria of replacement ram

Table 5 shows the proportion of farmers considering the different criteria for selecting their replacement rams from different breeds of sheep. Similar to the ewe selection criteria, multiple criteria were chosen for ram replacement, with

Table 5. Proportion of breeders considering replacement ram selection criteria for the different sheep breeds

Breed	No.	GR	BM	BP	FR	BT	DR	LE	MR	RS	DT	DM	TS
P-value:		*0.0013*	*0.48*	*0.018*	*0.081*	*0.10*	*0.047*	*0.0008*	*0.0019*	*0.79*	*0.0024*	*0.064*	*0.60*
Awassi	100	85	81	61	55	50	45	33	31	30	27	24	14
Chios	7	100	71	43	43	57	43	29	29	29	43	14	0
Crossbred	15	100	87	67	73	80	67	67	60	47	60	53	27
Hari	5	100	80	40	60	40	20	20	40	20	40	20	20
Indian	6	100	100	83	83	83	17	33	0	33	33	67	17
Jaziri	6	100	83	17	67	67	67	83	83	0	67	0	0
Najdi	155	90	87	60	53	43	41	28	27	26	20	21	19
Orb	41	63	76	27	42	37	34	39	29	27	12	17	20
Pakistani	4	75	75	50	0	25	50	50	0	25	25	50	25
Somali	14	86	57	64	86	29	71	71	57	21	50	29	7
Sudani	9	89	78	56	44	44	33	0	0	33	11	33	0
Habsi	4	50	75	50	75	75	0	50	25	0	25	25	0
Others*	5	100	80	40	60	40	0	0	0	20	0	40	0
Overall average	*371*	*86*	*82*	*56*	*55*	*46*	*42*	*34*	*30*	*27*	*25*	*24*	*16*

GR: Growth rate, BM: Body morphology, BP: Breed purity, FR: Fertility, BT: Being twin, DR: Disease resistance, LE: Lambing ease, MR: Mortality, RS: Ram source, DT: Dam twining ability, DM: Dams merit, TS: Testicle size

*Others: American, Afghani, South African, Omani and Muflon

three subjective out of twelve criteria. However, more subjective selection criteria were emphasized on rams than that on ewes and more significant differences were found among the different ram breeds of sheep for the different selection criteria chosen by the farmers than that for ewes (Table 5). This could be due to that farmers were more concerned with selection for rams than that for ewes. Although the first most important selection criterion was objective, whereas the second and third were subjective criteria. Similarly, researchers reported farmers chosen both subjective and objective criteria though they emphasized subjective criteria more for replacement males than that for replacement females (Kebede et al., 2012; Asefa et al., 2015). However, Tabbaa and Al-Atiyat (2009) reported that Jordanian farmers used more subjective criteria for female than that for male. In general, growth rate was highly significantly ($P < 0.01$) more emphasized for selecting the exotic breeds than that for the local and Arab peninsula breeds. Researchers also reported farmers' emphasis on growth as the first important selection criterion for male replacement (Ahmed et al., 2015; Abraham et al., 2017). However, Kebede et al. (2012) reported that farmers in some regions of Ethiopia rank the growth rate as selection criterion for males in the last order. Though, other criteria were also emphasized by farmers such as disease resistance, twining ability, fertility and body morphology in addition to male sexual ability traits (Kebede et al., 2012; Ahmed et al., 2015). The overall average for emphasizing body morphology criterion for the different breeds was 82% with no significant differences (Table 5). However, farmers link some body morphology traits to production traits, espe-

Table 6. Factors affecting replacement ram selection criteria for sheep breeds and their odds ratios

Factor	GR	BM	BP	FR	BT	DR	LE	MR	RS	DT[1]	DM	TS
Breed *P-value:*	*0.0013*		*0.047*							*0.0027*		
Awassi vs Others	0.00		2.80							1.02		
Chios vs Others	1.14		1.54							1.93		
Crossbred vs Others	1.04		3.20							3.91		
Hari vs Others	0.95		0.95							1.89		
Indian vs Others	0.67		5.58							1.43		
Jaziri vs Others	1.03		0.28							4.38		
Najdi vs Others	0.00		2.52							0.84		
Orb vs Others	0.00		0.62							0.31		
Pakistani vs Others	0.00		1.38							0.99		
Somali vs Others	0.00		3.35							2.09		
Sudani vs Others	0.00		1.92							0.42		
Habsi vs Others	0.00		1.40							1.00		
Region *P-value:*	*0.0052*	*0.0009*		*<0.0001*		*<0.0001*	*<0.0001*	*<0.0001*	*0.0052*	*0.045*		
Abu Dhabi vs Al Dhafra	9.81	3.85		0.20		0.02	0.40	0.28	0.39	0.53		
Al Ain vs Al Dhafra	1.16	2.77		0.18		0.07	0.19	0.13	0.66	0.43		
Gender ownership									0.0448			
Male vs Female									2.22			
Property type *P-value:*	*0.0067*	*0.032*			*<0.0001*			*0.0023*				*0.0003*
Random vs Registered animal farm	1.29	0.67			0.23			4.60				8.48
Mixed farming vs Registered animal farm	0.40	0.35			0.41			3.00				5.38
Flock Type *P-value:*			*0.0008*	*0.0066*		*0.0063*	*0.0004*	*0.005*	*0.0005*		*0.042*	
Pure sheep vs Mixed			2.32	2.83		2.23	0.29	0.27	3.50		0.45	
Flock size[2] *P-value:*		*0.0053*	*0.047*	*0.033*				*0.014*	*0.0005*		*0.0077*	*0.019*
Small vs Large		0.35	1.25	0.45				2.84	0.65		0.72	1.14
Medium vs Large		0.42	0.61	0.64				1.35	0.31		0.47	0.43

GR: Growth rate, BM: Body morphology, BP: Breed purity, FR: Fertility, BT: Being twin, DR: Disease resistance, LE: Lambing ease, MR: Mortality, RS: Ram source, DT: Dam twining ability, DM: Dams merit, TS: Testicle size

Others: American, Afghani, South African, Omani and Muflon

[1]Odds ratios for dam twining ability were calculated all breeds versus Habsi sheep since all Others breeds were zeros

[2]Flock size: small < 150, medium 151-350, large > 350 heads

cially meat production and use them as tools for production improvement (Asefa et al., 2015). Breed purity, fertility and ram being one of the twins were emphasized by 55%, 56% and 46% of the farmers, respectively, with no significant differences among breeds.

Disease resistance criterion was significantly ($P < 0.05$) different chosen by farmers of different sheep breeds and ranging from 0% for Habsi and Others breeds to 71% for Somali sheep, with overall average of 42% for all breeds (Table 5). Lambing ease and mortality were highly significantly ($P < 0.01$) different among different breeds. Lambing ease was ranging from 0% for Sudani and Others breeds to 83% for the Jaziri sheep while mortality was ranging from 0% for different sheep breeds to also 83% for the Jaziri sheep. Ram source was emphasized by 27% of the farmers with no significant differences among breeds. Dam twining ability and its overall merit were emphasized by only 25% and 24% of the farmers while ram testicle was emphasized only by 16% of the farmers. As it appears, no specific trends for the related criteria, which may indicate that farmers' decisions on criteria were not defining their breeding objective correctly and choosing selection criteria accurately.

Factors influencing selection criteria of replacement ram

Multiple logistic regressions results show that all factors studied were influencing the farmers' decisions on some replacement rams' selection criteria (Table 6). Breed of sheep influenced farmers' decision on growth rate, breed purity and dam twining ability. Most exotic breeds have odds ratios (OR) for growth rate that were significantly ($P < 0.01$) much higher than that for local and Arab peninsula breeds which got zero OR. No specific trend for OR were found for breed purity, it was the highest for Indian sheep (5.58) and was lowest for Jaziri (0.28), where both breeds are exotic. Odds ratios for dam twining ability were recalculated based Habsi breed since the value for Others breeds was zero. The highest OR for dam twining was for Jaziri breed and lower values were found for local and Arab peninsula breeds.

Region significantly influenced 8 replacement ram selection criteria (Table 6). As the ORs reveal, growth rate and body morphology were 9.81 and 3.85 times, respectively, more emphasized in Abu-Dhabi region than that in Al-Dhafra. In Al-Ain region, the ORs for these two criteria were 1.16 and 2.77 times, respectively. Other criteria were more emphasized in Al-Dhafra region than that emphasized in both Abu-Dhabi and Al-Ain regions which include fertility, disease resistance, lambing ease, mortality rate, ram source and dam twining ability (Table 6, Figure 1A). Similar results were obtained by researchers who found differences in selection criteria among different regions (Kebede et al. 2012; Santos et al. 2015; Nandolo et al., 2016). However, Asefa et al. (2015) reported that selection criteria were not different among different regions for both male and female replacement though they were ranked differently.

Gender of farm owner was only significantly ($P < 0.05$) influenced the ram source selection criteria (Table 6, Figure 1B). Ram source selection criteria was emphasized 2.22 times more by male owners than that by females. This is also due to social acceptance and that male farmers are more able to travel outside their regions, even to other countries such as Saudi Arabia and Kuwait and others, to bring good rams to their farms.

Property type influenced 5 replacement ram selection criteria which include growth rate, body morphology, ram being one of twins, mortality rate and testicle size (Table 6, Figure 1C). Owners of the random animal farms were 1.29, 4.60 and 8.48 times more concerned with replacement ram growth rate, mortality rate and testicle size, respectively, than that registered animal farm owners concerned, as ORs revealed. However, mixed farm owners were 0.40, 3.00 and 5.38 times, respectively for the same criteria, more concerned than that registered animal farm owners concerned (Table 6). Though, registered animal farm owners were more concerned with body morphology and replacement ram being one of twins than both farms owners. Similar results were reported by Ahmed et al. (2015). Pure sheep flock owners were significantly ($P < 0.01$) more concerned with breed purity, ram fertility, disease resistance and replacement ram source and less concerned with lambing ease, mortality rate and dam merit than mixed flocks with goats (Table 6, Figure 1D). As flock size increase, farmers were significantly more concerned with body morphology and fertility and less concerned with mortality rate (Table 6). In one hand, farmers of the medium size flocks were less concerned with breed purity and testicle size while small size flock owners were most concerned. On the other hand, farmers of the medium size flocks were less concerned with replacement ram source and dam merit while large size flock owners were most concerned (Table 6, Figure 1E). Lopes et al. (2012) concluded that the choice of selection criteria and their economic weight that need to be included in the selection index should be specific for each production system to achieve the most possible profit from a production system.

Conclusion

Farmers of Abu-Dhabi Emirate had multiple breeding objectives and they considered both subjective and objective selection criteria to achieve these objectives. They also were more emphasising on morphological characteristics for

replacement ram selection than ewes. However, meat production was the main breeding objective that was chosen by most farmers. Though, differences due to breed, region and production system including property type, flock size and type need to be considered when determining selection criteria and economic weights that to be included in the selection indices in order to achieve maximum possible genetic improvement out of a sustainable breeding program for sheep. Therefore, efficient extension program need to be launched to promote efficient selection strategy with predefined breeding objective and selection criteria.

Aknowlegements

The authors are grateful to Abu-Dhabi Food Control Authority (ADFCA), Abu-Dhabi, UAE, for the financial support and to all persons who helped and gave support in achieving this study and it is hard to mention their names.

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Received: 20.04.2018; ***Accepted:*** 17.05.2018