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RESEARCH ARTICLE

Assessment of camel owners' knowledge and practical behaviors and its implication on environmental sustainability

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ABSTRACT

This study aimed to assess camel owners' knowledge and practical behavior (KPB) in Saudi Arabia (KSA) and their implications on environmental sustainability. The study depended mainly on primary data. An online questionnaire survey was used to collect data from 267 respondents, in 2022. Descriptive and analytical techniques were used to achieve the stated objectives. Results revealed that, the majority of camels' owners (91.7%) have low cumulative KPB, which was evident in their traditional practice and non-commercial methods in herd management. Moreover, large numbers of breeders do not sell their milk production due to their traditions, thus, about 23% of them gained no profits. Results also showed that, about 85% of owners were located in the lower level of using cost items (modern technology and labor training), accordingly, 96.6% fall within the low level of profit category. Likewise, about 75% of camels' owners' grazing behavior were located in the lower and medium level groups. Furthermore, the cumulative (KPB) effect of age, educational level, main job, training levels, cost of production and grazing behavior were found to be statistically significant in explaining CKPB variations of camels' owners in KSA. The R^{-2} indicated that 59% of the variations in the dependent variable was explained by the variations of the independent variables. The also revealed the presence of high degree of positive association between camels' owners' CKPB and environmental sustainability. This study stresses on the importance of execution of sound agricultural extension programs and veterinary campaigns to improve camels' owners' CKPB.

Keywords: Camel raising; Environmental sustainability; Grazing behavior; Knowledge and practical behavior; KSA

INTRODUCTION

Camels play a major role in the lives of the citizens of the Kingdom of Saudi Arabia (KSA), due to their close connection with the heritage of the past. The animal is distinguished by its high adaptability to the nature of the Kingdom's arid lands and its climate, especially in the very hot summer (Schwartz, 1992). In fact, the relationship of camels with the society of KSA is an example of the ability of humans and animals to adapt to the conditions of the desert life.

In the past, the inhabitants of the Saudi Arabian relied more on natural endowments, thus camels had an important impact on the details of their daily lives as a source of food (milk and meat), clothing and housing (fiber and skin), and as means of transportation in peace and war. However, after petroleum discovery, the Arab men in the Kingdom hold on to camels; hence, camels became an icon for their heritage, life and economy, in addition to, being a source of pride among tribes, a symbol of social status and a storehouse of wealth, where the price of a camel may reach several millions Saudi Riyals, in addition, to the keenness of many breeders to preserve camels as an integral part of their historical customs and traditions. Yet, camels can have a double-edged effect on environmental sustainability: a positive effect when good management of natural pastures is practiced and regulations are adopted for

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controlling grazing areas (natural reserves) and a negative effect through overgrazing. However, the awareness of camel herders and the level of their knowledge and practical behavior with regard to camel herds raising and caring is considered as an indication of their ability to achieve technical and economic efficiency and to contribute to the development of specialized breeds with a comparative advantage in the production of milk and meat or dual purposes. In fact, there are many factors that affect the level of knowledge and practical behavior of camels' owners such as technical factors related to feeding and veterinary care...etc., personal, social and economic factors related to the camels' owners themselves, which are certainly reflected in the method of breeding and camels caring, without jeopardizing the environmental sustainability. It is to mention that, Milewski, and Smith (2019) argued that, the environmental sustainability indicators for aquaculture-fish operations are the quantity of resources use, waste discharges, chemical use, disease incidence, escaped fish, genetic interactions, and impacts on biodiversity.

The importance of improving camels' owners' knowledge and practical behaviors is an essential preventive measure for the safety of camel herds, individual and their community. There are many areas for improving camel owner's behaviors such as improving their awareness on camel breeding and health care methods, vaccinations programs, and grazing recommendations…etc. These could be done through the implementation of effective extension programs based on actual needs assessment. Hence, the level of knowledge and practical behavior of camels' owners in KSA need to be well assessed before setting the right extension programs. In this context, different studies has been covered the topics of knowledge and practical behavior of camels' owners in the world and KSA. For instance Musallam et al. (2015) evaluated knowledge, attitudes, and practices behavior of livestock owners' regarding brucellosis in Jordan. Their results revealed that all interviewed livestock keepers were aware of brucellosis: 87% and 75% indicated a high risk of infection in consuming each of unpasteurized milk and dairy product, respectively. Livestock owners showed low level of awareness regarding the direct contact with fetal membranes or via physical contact with infected livestock. They recommended that public health education should be considered. Similarly, Abd El-Wahab and others (2019) stressed on the importance of improving the knowledge, attitude and practices of the community in dealing with the effective prevention and control of brucellosis in Egypt.

Marshall et al (2018) documented livestock breeding practices of Somali pastoralists including camel. Livestock in the country plays an important role in reducing poverty and increasing food security. The authors recommended that, capacity building in the field of breeding is essential matter for improving knowledge and practice of the owners.

Kothowa et al. (2021) studied the associated knowledge, attitudes and practices of farmers with the bovine brucellosis in dairy cattle herds in Malawi, they found that, the majority (94.2%) of smallholder farmers had never heard about brucellosis. Moreover, slightly more than half of the respondents (50.8%) did not know that brucellosis diseases can transmitted from dairy animals to humans. In the same veins, a considerable amount of knowledge and practical behaviors of farmers (41.3%) in assisting cattle during parturition was done without using protective equipment.

Alemayehu and Doda (2020) investigated the indigenous environmental knowledge (IEK) of cattle pastoralists in Southern Ethiopia. They argued that, IEKs of the studied pastoralists are facing threatening challenges that question their existence.

Madalcho and others (2019) identified the major plant species browsed and grazed by camel and their seasonal availability in pastoral and agro-pastoral areas. They also stresses on the importance of raising camels' owners' awareness on sustainable management browsed grazing plant species and their utilization.

Based on aforementioned background, this study aimed to study factors affecting the level of knowledge and practical behavior of camels' owners in the Eastern Province of Saudi Arabia and their implication on environmental sustainability. Moreover, this study examine the socioeconomics characteristics of camels' owners and identify their level of knowledge and practical behaviors, in addition to, investigates the relationships between socioeconomics factors of the respondents and the cumulative effects on knowledge and practical behaviors of camels' owners. The study also aimed to examine the association between the level CKPB and environmental sustainability.

The study is divided into four sections. The first section was the introduction. The second and third sections was devoted to the material and methods, and results, while the last section was the discussions in addition to the conclusion.

Camel in KSA

The contribution of agricultural sector on Saudi GDP has increased in the recent years from 2.6 in 2015 to 2.7 2020 (FAO 2022), it is however important to mention that, livestock sector plays a significant role in the

agricultural sector of KSA as it contributes about 61% to the agricultural GDP (FAO 2007). Over the years, this sector has witnessed significant changes in the mode of production methods, such as improve the availability and utilization of crop residues, supplementary animal feeds, mechanized pastoralism and introduction of modern production units (Bourn, 2003). With the transportation of animal feed supplies and water tank trailers, pastoral livestock production is no longer dependent on rainfall and range conditions as it used to be. Traditional seasonal patterns of movement to and from specific areas are no longer followed and have been replaced by more erratic and opportunistic movements to areas with seasonal crop residues and natural pasture, and where water and supplementary feed is supplied. The country had made vehicles available at subsidized rates to assist pastoralists in transporting their animal. Attempts to settle the pastoralists in the country go back to 1910, when King Abdul Aziz moved Bedouin into what is called Hijra schemes. These centers grew until 1929, when a revolt destroyed them and they have completely reverted to herding settlements by the 1950s, (Chatty, 1990). It is worth noting that, KSA government is making more efforts to support livestock owners especially camels' owners through provision of veterinary services, subsidization of fodder, rehabilitation of grazing areas and constructions of road barriers to reduce accidents resulting from the movement of camel herds between grazing areas.

Al-Swailem et al. (2007) classified Saudi camel population into three main breeds, namely black (Magaheem), white (Magateer) and brown (Alhomr and Alsofr). In fact, there is no scientific classification for camel population in KSA; however, the population can be classified according to habitat, color or function. Improvement in camel production requires integrated approaches to counteract the effects of land degradation, feed scarcity, poor infrastructure and people attitude. In almost all strategic development plans that will be designed for camel, a breeding component is usually inevitable for both conservation of indigenous genetic resources and/or genetic improvement of performance (Cardellino, 2005).

Human exploitation of rangelands in arid zones is influenced by several limiting factors. Animal density depends largely on the consumable plant biomass. Duba and Ellis (1978) mentioned that camel can go up to 14 days without water and since they can travel around 5 km/hour, it is possible to graze camels in a wide ranging pattern. Unpredictable distribution of rainfall means that the spatial distribution of humans and animals is highly variable. Even though general migration routes are traditionally, well-defined, day to day decision making has to be opportunistic. Thus, whatever strategies humans use for arid land grazing they must exhibit considerable flexibility. Such flexibility is frequently shown in the social relations among minimal social units. Factors such as animal physiology and climate can combine to encourage two different patterns of Bedouin exploitation of the Arabian range. One of these patterns centers on the camel and the other on small stock (sheep and goats).

Profound changes in pastoral livestock production have also taken place in Saudi Arabia over the past years, as documented by Ahmad (1998); and Abdulla et al. (1998). Traditional nomadism as a production system no longer exists in Saudi Arabia. There is noticeable decrease in the number of pastoralists in the country. Furthermore, there is a tendency towards settlement of pastoralists. Pastoralists who constitute less than 10% of the total population (Al Humaidi, 1994) keep about 40% of camels in the country. Dependency on range forage as a basic feed resource has declined from 100% to less than 20%. Moreover, nomadic movements have been mechanized and camel management systems were commercialized. Abbas et. al. (2000) studied camel herds in Al-Qasim region, and identified four distinct herding strategies for the husbandry of camels in the area, namely commercial dairy herds, family prestige herds, pastoralist and agro-pastoralist herds and peri-urban feedlots herds. The largest number of camels was found in the dairy herds, where two herds had 2100 and 420 animals, however, the average herd size was 92 heads. As it could be seen, only two herds were operating on a large commercial scale, while the others were not. Moreover, Faye et al. (2014) studied the value chain of camel milk in KSA and argued that, only 13.5% of the camel milk produced in the northern part of Saudi Arabia went for markets while the rest was for self-consumption only.

Furthermore, Abdallah and Faye (2013) argued that, camel raisers whether living in the desert or urban areas has variable methods for integration to the markets. On the other hand, Abouheif et al. (1990) study the bodyweight of of Najdi-camels and concluded that the average body weight at the age of 8, 16 and 26 months are 171.2, 295.4 and 450.9kg, respectively. Al-Eknah, et al., (2001) studied the gestation length of Saudi camel and argued that it ranges between 317.3 to 387.7 days.

MATERIAL AND METHODS

Study area

This study was conducted in the eastern region of KSA. The major farming system in Saudi Arabia is the sparse arid system, characterized by very arid rangelands where livestock are kept by nomadic pastoralists on annual grasslands across the kingdom (Bourn, 2003). This system

covers the extensive desert areas of the country. The sparse rainfall limits traditional human utilization of the Arab peninsula to extensive herding, terrace agriculture or irrigation agriculture in a few scattered oasis and valleys. Some oasis contains farming and a number of irrigation schemes, and provides opportunistic grazing for the herds of pastoralists from scattered storms and in good seasons. This domination is largely because rangelands that are unsuitable for agriculture comprise over 90% of Saudi Arabia. Furthermore, historically over 70% of the population of Arabia is probably nomadic herders. Camel breeding is a vital means for the exploitation productive lands in the arid zones. Without this practice, most of the arid and marginal areas in the country will be abandoned. Because of the great attention paid to the agricultural sector, two distinct agricultural sub-sectors have been emerged in KSA: the first one is based on modern, large-scale, high-input production units; while the second is derived from traditional farming and pastoral systems (Alshuaibi and Ismail, 2013).

Saudi Arabia occupies the third position in the world, after Somalia and Sudan, in terms of camel's heads. The country witnessed a considerable increases of camels numbers overtime, as they increased from 813 thousands heads in 2013 (AOAD, 2017), to approximately 1.4 in 2018 and reached up to 1.5 million heads in 2020 (Fig. 1), however, these wealth is distributed all over the country (Fig. 2). The Eastern Province of the Kingdom ranked second after Riyadh in terms of camel numbers holding 243.3 thousand heads, with an average increase of 16.2% for the period 2013 - 2018 (Ministry of Environment, Water and Agriculture, 2020).

Data sources

This study was based on both primary and secondary data. Primary data was collected from camel-owners' in the eastern region of KSA, by means of questionnaires prepared purposively for this study and distributed to 267 respondents through online google form during the period from October 2021 to January 2022. However, it is noteworthy to mention that, 14 questionnaires were excluded from the sample, because the respondents were outside the studied region but came for grazing in the eastern region. The questionnaire covered data on camel-owners' socioeconomic characters and capacity building they received in camel raising; herd types, herd structure and management in addition to their knowledge and practical behaviors of camel raising. It is also important to note that, this study was conducted in accordance with the regulations of the Scientific Research Ethics Committee - Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, Saudi Arabia [72].

Analytical techniques

Descriptive statistics, mean comparison (cross- tabulation), and stepwise linear multiple regression model were used to achieve the stated objectives.

The applied linear multiple regression model is in the form of:

$$Y_i=\alpha_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4+\beta_5 X_5+\beta_6 X_6+\ldots.+\beta_{12} X_{12}$$

Where:

Y_i=Cummulative of all camel-owners' knowledge and practical behavior. The studied knowledge and practical behavior include summation of all practical scores gained by camels' owners: knowledge and practice in dealing with antibodies resistance bacteria; vitamins usage; attending training courses; herd management in terms of structure; records keeping; animal housing, regular weighing of

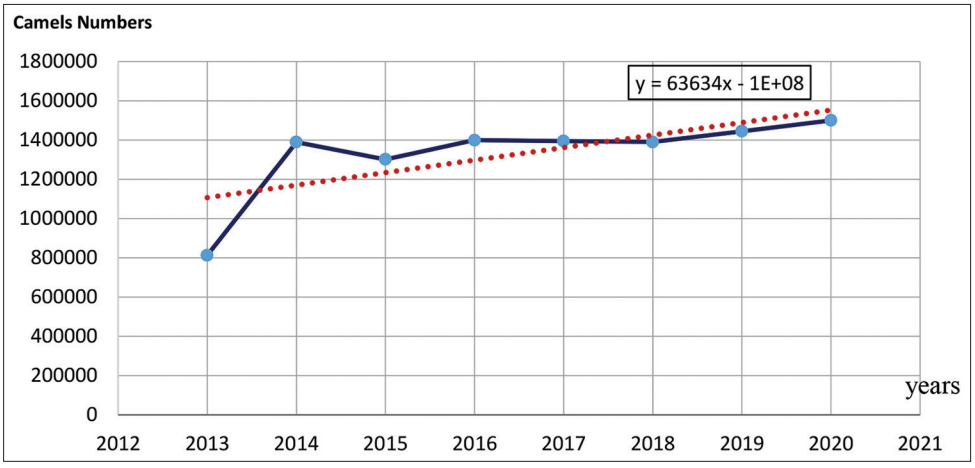

Fig 1. Trends of camels' numbers in KSA for the period 2013 -2020
Source: Arab organization for agricultural development, 2017; Ministry of environment, Water and Agriculture KSA, 2020; General authority for statistics 2019.

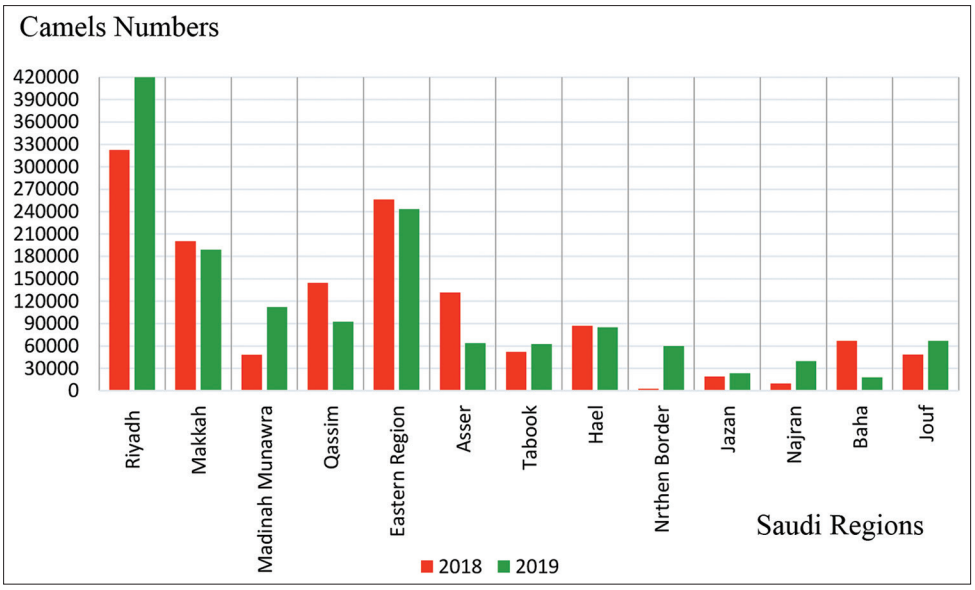

Fig 2. Camels numbers in KSA regions 2018/2019 –2019/ 2020
Source: General authority for statistics, KSA (2019), Ministry of environment, Water and Agriculture KSA, 2020.

animals, animal vaccination; animal reproduction; crossing road in specified area and pest control. The score gained by each camels' owners range between 12 minimum and 35 maximum with mean 22.5 and coefficient of variation 21%.

X_1=age of the respondents in years

X_2=educational level (scale from one to seven; 1= illiterate, 2=read and write, 3=primary school, 4=intermediate school, 5=secondary school certificate, 6= university, 7=postgraduate studies)

X_3=main job is indicated by scale ranging between one and seven; 1=government job, 2-private sector job, 3=trader and/or free worker, 4=agriculture works and 5=camels' owners).

X_4=training received by camels' owners is represented by scale started from 0 to 24. The training scores were obtained from the multiplication of three variables; received training (1=No and 2=Yes); if yes number of days; and level of satisfaction (1=none, 2=low level, 3= intermediate level, 4 high level)

X_5=total cost of camel production (Saudi Riyals (RS)).

X_6=profit (IN Saudi Riyals (RS)).

X_7=purpose of camels' ownership was represented by scale ranged between one and nine (1=tradition and inhered, 2=habits, 3=milk production, 4=meat production, 5=camel racing, 6=competition of animal beauty (*Mazzain*). Moreover, accumulative combination were used for multipurpose ownership as shown hereafter: 7= competition of animal beauty (*Mazzain*) + meat production. 8= competition of animal beauty (*Mazzain*) + meat production + milk production and 9= competition of animal beauty (*Mazzain*) + meat production + milk production + camel racing.

X_8=source of camel and was obtained from the multiplications of two factors (origins of animals (1=foreign animals obtained from outside Saudi Arabia and Gulf countries, 2=obtained from Gulf countries; 3= the local types of animals); Numbers of camels)

X_9=record keeping obtained from the multiplications of two factors (hearing about records keeping (1=No and 2=Yes) and keeping records for herds (1=N0 and 2=Yes)).

X_{10}=numbers of male in the herd as indication of herd structure management

X_{11}=numbers of female in the herd as indication of herd structure management

X_{12}=camel grazing behavior which was used as an indication of environmental sustainability was designated by scale ranging between one and nine. According, each respondents was given score from one to nine. The score was calculated through the multiplication of three factors: types of feedings (1=concentrated ration and forages, 2=open public grazing area), person taking care of the animal (1=rented labors, 2=owners and his family, 3=owners themselves), and ownership of grazing area (1=open public grazing area, 2=private close area). Pertaining the issue of ownership of grazing area, it is worth noting that, camels owners usually exerts no efforts to ensure sustainable use of their grazing resources.

$\beta_1,\beta_2,\beta_3,\beta_4,\beta_5,\beta_6,\beta_7,\beta_8,\beta_9,\beta_{10},\beta_{11},\beta_{12}$ = coefficients to be estimated

α_0 = intercept

On the other hand, Chi square analysis was used to study the relationship between the level of CKPB category and

the grazing behavior category. It is worth noting that, each of the study group was categorized into three categories (low, medium and high).

Research hypotheses

In order to study the relationship between the independent and dependent variables, both theoretical hypotheses and the statistical hypotheses were derived to describe the relationship among studied variables in one hand, and to achieve the research objectives on the other hand. Accordingly, a general hypothesis was stated and from which 13 other statistical hypotheses were derived.

The general hypothesis: stated that no relationship exists between the level of KPB of camels' owners and the independent variables studied.

Statistical hypotheses (from 1-12): twelve statistical hypotheses were derived from the general hypothesis, all of which share the same view: the level of KPB of camels' owners is not influenced by each independent variables: age, educational level, main job, training received by camels' owners, total cost of production, profit, purpose of camels' ownership, source of camel, record keeping, numbers of male in the herd, numbers of female in the herd, camel grazing area.

Statistical hypotheses (13): was concerned with the testing of the cumulative effect of the independent variables on the level of KPB of camels' owners.

The mathematical form of the equation can written as follows:

H_0:α_0=0; The alternative hypotheses is; H_0:α_0=0

Whereas the tested hypotheses for the independent variables were:

The null hypotheses: H_0: $\beta_1,\beta_2,\ldots\beta_{12}$=0;

The alternative hypotheses: H_0:at least onr of $\beta_1,\beta_2\ldots\beta_{12}\neq0$

RESULTS

Result of the descriptive statistics of the cumulative KPB of camels' owners' (Y) in the eastern region of KSA as shown in Table 1 and 2, revealed that, the average score

Table 1: Descriptive statistics of the studied socioeconomics factors of camels' owners in KSA

Studied Variable	Mean	Standard Deviation	Minimum	Maximum	Coefficient of Variation
knowledge and practical behavior (Y)	22.48	4.71	12.00	35.00	0.21
Age (X_1)	41.50	12.2	19.00	80.00	0.29
Educational level (X_2)	4.10	1.70	1.00	7.00	0.41
Main jobs (X_3)	2.36	1.34	1.00	5.00	0.57
Training received by camels' owners (X4)	7.25	8.61	0.00	24.00	1.19
Total cost of camel production (SR/month) (X_5)	12011.93	8863.67	1980.00	63800.00	0.74
Profit (X_6)	91979.39	209356.93	0.00	1988450	2.28
Purpose of camels' ownership (X_7)	5.61	2.01	1.00	9.00	0.36
Source of Camel (X_8)	95.41	93.31	7.00	594.00	0.98
Records keeping (X_9)	2.51	1.34	1.00	4.00	0.53
Numbers of male (X_{10})	7.30	10.02	1.00	105.00	1.37
Numbers of female (X_{11})	17.58	18.31	1.00	180	1.04
Grazing behavior (X_{12})	5.21	1.92	1.00	9.00	0.37

Source: online survey (2021) , One US$=3.75SR

Table 2: Distribution of studied socioeconomics factors of camels' owners in KSA into three categories (low, medium and large) according to the actual range of each factor

Studied Variable	Low category		Medium category		High category	
	No.	%	No.	%	No.	%
knowledge and practical behavior (Y)	243	91.7	0	0	22.0	8.3
Age (X1)	116	43.8	138	52.1	11	4.2
Educational level (X2)	91	34.3	103	38.9	71	26.8
Training received by camels' owners (X4)*	160	60.4	61	23	57	21.5
Total cost of camel production (SR/month) (X5)	225	84.9	37	14	3	1
Profit (X6)	256	96.6	8	3	1	0.4
Records keeping (X9)	152	57.3	1	0.4	112	42.3
Numbers of herds (male (X10) and female (X11)	256	96.6	8	3	1	0.4
Grazing behavior (X12)	44	16.6	156	58.9	65	24.5

Source: online survey (2021)
*52.5% never-trained owners

gained by animal owners was 22.5±4.71 with the minimum value 12 and maximum 35. On the other hand, the average age (X_1) of the respondents was 41.5±12.2 (minimum 19 and maximum 80 years), with the bulk (95.9%) fall within the active age groups: lower (19-39 years) and middle age groups (39–59 years). On the other side, the average educational level of camels' owners (X_2) was 4.1±1.7 with minimum 1.0 and maximum 7, however, its distribution was as follow: illiterate; read and write; primary school; intermediate; secondary school; undergraduate and postgraduate 7.5%, 17.6%, 8.4%,18%. 22.6%, 22.6% and 3.3% respectively. However, when divided into three equal categories they revealed that, 34.3 of them had lower educational level, 38.9% fall within the medium educational level and 26.8% were in the high educational level. On the other hand, the average score of the main job (X_3) of the camels' owners was 2.36±1.34 with minimum 1.0 and maximum 5, nevertheless, they were distributed as follows: governmental employee (37.2%), private sector employee (17.6%), traders and private business (10.9%) farmers (7.5%), camel raisers (26.8%). Results of the training received by camels' owners (X_4) indicated that, training level of the respondents ranged between zero and 24 with mean 7.25±8.61, minimum zero and maximum 24. Yet, most of them gained low level of training (60.4%), other categories were middle (23%) and high (21.5%) level of training.

The average running cost of camel herd (X_5) in the region was found to be more than 12 thousand Saudi Riyals (SR)/ month, with minimum of 1980SR, maximum 63800SR and standard deviation 8863.67. The cost item were categorized as follows; 84.9% of the owners were located in the lower level, 14% in the middle level and 1% in the high level (such 1% breeders might use modern technology in their herds management). In the same vein, the average profit gained by herds' owners' (X_6) was found to be 91979.39SR±209356.93 (minimum zero and maximum 1988450SR). In this context, it is worth noting that 22.6% of the camel owner gained zero profit. It is also noticed about 97% of owners were in the lower category of profit.

The purpose of respondents for camels' ownerships (X_7) was categories into nine level, with the mean 5.6±2.0, minimum one and maximum nine. The lower level goes for those who raise animals for hobbies, traditions and funs (3%); while the highest level goes for commercialized production with the highest returns obtained from animal beauty competition (*Mazzain*) and goes further for the multipurpose activity. Moreover, the camel racing occupied the first position as reason of ownership (23.4%) followed by animal beauty competition (*Mazzain*) (19.2%) and a combination of competition of animal beauty (*Mazzain*) and meat production (17.4%). However, the rest of purposes gained less than 40%.

Pertaining the source of camels' ownership (X_8), almost all producers have mixed herds obtained from different sources such as Saudi, Arabian Gulf countries, African origins (Sudan and Somalia). However, very minute numbers of them obtained their animals from Australia.

Results of records keeping (X_9) showed that, the average scored gained by breeders were 2.51±1.34 (minimum 1, and maximum 4). It is worth noting that, camel raisers were categorized according to the level of keeping records into three categories lower, medium and higher. About 57.3% of the owners were in the low category, while 0.4% and 42.3% fall within the middle class and in the higher class, respectively.

The average herd number was found to be 24.9 heads out of which there were 7.3±10.02 male (X_{10}) and 17.58±18.31 female (X_{11}). According to herd size animal breeders were classified into three categories: lower, medium and higher categories. About 96.6% fall within the lower category, 3% in the middle category and 0.4 in the higher one. Moreover, more than 42% of the owners owned 13 female camels or less and less than 46% have 5 male camels or less. Likewise, grazing behavior (X_{12}) owned by each camel owner (mean 5.21±1.92 with minimum 1.0 and maximum 9), were classified into three level: lower, medium and higher level. Nevertheless, the distribution of camels' owners within the specified categories were as follows 16.6% were in the lower group, 58.9% in the middle and 24.5% in the high group.

Effect cumulative factors on camels' owners' knowledge and practical behaviors

Results of the stepwise multiple linear regression techniques that was used to investigate the effect cumulative factors on camels' owners' KPB is presented in Table 3.

The resulted regression equation is shown in Table 3 as:

$$Y = 1\ 4.2 + 0.07X_1 - 0.89X_2 + 2.21X_3 + 0.09X_4 + 0.001X_5 + 0.45X_{12}$$

It is very clear that, R^{-2} was 0.589%. This implies that about 59% of the total variation in the camels' owners' knowledge and practical behaviors was explained by the variations in the explanatory variables (Table 3). This indicates a considerable degree of association between the independent and the dependent variables. The F-statistics was 54.09 and is statistically significant, implying that the independent variables were collectively important in explaining the variation in the dependent one.

On the other hand, results of the chi square test that was used to examine degree of association between level of CKPB category and the environmental suitability category was presented in (Table 4).

Table 3: Results of the regression analysis of the effect cumulative factors on camels' owners' knowledge and practical behaviors

Studied Variable	Coefficient	t- value
Constant (α)	14.2	18.81*
Age (X_1)	0.07	2.79*
Educational Level (X_2)	-0.89	-5.44*
Main job (X_3)	2.21	11.00*
Training received by camels' owners (X_4)	0.09	3.67*
Total cost of production (X_5)	0.001	4.12*
Grazing behavior (X_{12})	0.45	4.00*

F-value=54.09, which is significant at (0.001%).
R^2=0.598, R^{-2} = 0.589
**T- value which significant at 1% level

Table 4: Results of the Chi-Square test for the association between the cumulative camels' owners' knowledge and practical behaviors and environmental sustainability

Test	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	41.165a	4	0.000
Likelihood Ratio	40.858	4	0.000
Linear-by-Linear Association	14.539	1	0.000
N of Valid Cases	265		

Sources: Authors' calculation from the surveyed data (2022)

Results of the Chi square that was used to investigate the association between the cumulative camels' owners' knowledge and practical behaviors and environmental sustainability indicates that, the Pearson Chi-Square test value was 41.165 and the degree of freedom was 4.

DISCUSSION

Results of the descriptive statistics of the cumulative knowledge and practical behaviors (CKPB) of camels' owners' revealed that, the majority (91.7%) of camels' owners fall within the lower score category group which range between 12 and 20 (Table 2). This result might indicates that, the behaviors of most of the camels' owners in the eastern region of KSA goes for practicing traditional and non-commercial methods in managing their herd which reflected on their living conditions. This result coincides with the finding of Marshall et al (2018) who mentioned that, the knowledge of camels and other livestock species owners on breeding methods was poor, because they never considered mating of related animals to be problematic. Furthermore, a considerable amount of the respondents (43.8%) were in the lower age group (X_1), accordingly, they do not expect to have sufficient experience in dealing properly with their herds. In the same line, the educational level (X_2) of the majority of them (73.2%) are illiterate or attended intermediate secondary school or lower. Such findings showed that the respondents might not be able to apply modern techniques in managing their herds. This required the implementation of professional agricultural extension programs to improve the knowledge and practical behavior of the camel owners in KSA. Regarding the main job (X_3) of the respondents, less than 27% practice camel raising as a full time job. Yet, slightly more than 10% of them have commercially oriented minds as indicated by owners who practice trading/private business as the main job. In this regard, Ma et. al. (2019) studied "changes in traditional ecological knowledge of forage plants in immigrant villages of Ningxia, China" and found that there is a close correlation between associated knowledge of traditional forage plants reserved by ecological migrants and each of the gender, age, educational level, and occupation. Furthermore, the earlier findings is also confirmed by the results of training received by camels' owners'(X_4) in herds management as it indicate that, 83.4% of the respondents had lower or middle level of training. It is also worth to mention that, more than 52% of respondents never attended any training courses in camel herd management. The poor knowledge and practical behavior of the camel-owners coupled with their low investment in camel business (84.9% of the owners were located in the lower level cost items (X5)), both modern technology and labor training, has resulted in poor profit (X6) gained by the owners as indicated by the fact that 96.6% fall within the low level of profit category. Moreover, about 23% of the camels' owners received zero profit, despite the steadily increase of meat production in the Kingdom from 40 thousand tons in 2006 (Al-Mahish et al., 2018) to an average of 43.7 thousand tons for the periods from 2009 to 2013 and more than 63 thousand tons in 2016 (AOAD, 2017). In this regards it is worth mentioning here that, according to taste-panels in the Arab region, camel meat has better taste than beef meat, and young camel meat has the same taste of prime beef (Ahmad, et al 2010). Likewise, the KSA is considered as one of the largest meat consuming countries in the world, consuming 50.8 kilograms/person/annum compared to 31.1 kilograms for the rest of the world (Al-Mahish et al., 2018). Moreover, Aziz and others (2016), studied camel lactation in two different research station of KSA and found that, the averages milk yield, lactation length and daily milk yield of studied herds, ranged between 967.3 and 3107.21 kg/herd, between 273 and 416 days and between 2.96 and 7.40 kg/day, respectively. Nevertheless, large numbers of breeders do not sell their milk production due to the traditional behavior, which consider selling camel milk as shame. However, Al-Mutairi et. al. (2010) argued that the production system, nutritional, socio-economic and breeding constraints are responsible for the difference in production and profitability of camel in KSA.

Other implication of the poor CKPB of camel raiser in the eastern region of KSA is the high mortality among the first

year (male and female) (17%) followed by 2-3 years old females (9%) (Abbas et al., 2000). However, Agab (2002) reported an average mortality rate of 7.4%. The most common causes of mortality recorded by the Agab were "Heyam" syndrome, Diazinon toxicity, snakebites, calf diarrhea …etc.

On the other hand, it is clear from table 3 that, the intercept was found to be 14.20 and is statistically significant at 0.001 level of significance. This means that at zero level of all independent variables there would be reduction of camels' owners' knowledge and practical behaviors scales by 14 unit. On the other hand, a positive and significant relationship exist between camels' owners' knowledge and practical behaviors and their main jobs ($P<0.001$). This result shows that a one-unit increase in the scale of producer's main job, which moves towards specialization in camel raising, increases camels' owners' knowledge and practical behaviors by 2.21 units.

The coefficient for the educational levels was found to be -0.89, and is statistically significant at 0.001% level indicating that a unit increases in the educational levels decrease the knowledge and practical behaviors by 0.89 units. This negative relationship might be attributed to the fact that, educated camels' owners do not have enough time to manage their herds and in turn depend most time on low educated or illiterate hired labor. Moreover, more than 73% of the owners are not are practicing camel raising as a main job. This finding is in line with Bayyurt and Yilmaz (2012) who concluded an inverse relationship between education and agricultural efficiency. However, it contrasts the findings of Akudugu et al. (2012) who found a positive relationship between education of farm household and the probability of adoption of modern agricultural production technologies.

On the other hand, the coefficient on grazing behavior, training level and age were found to be positive and statistically significant in explaining the variations on the dependent variables ($P<0.01$). This means that, a unit increases in each of the grazing behavior, training level and age increases the KPB of camels' owners by 0.45, 0.09 and 0.07 units, respectively. According to Palada et al. (2020) training improved farmers' knowledge level by 33.14% compared to before training. However, Almadini et al. (2021) found an inverse relationship between training level and date production in KSA.

On the other hand, result of the Pearson Chi-Square test showed a statistically significant positive association between camels' owners' CKPB and environmental sustainability (P-value=0.0001). That is to say, the more the camels owners level of the CKPB are the more consideration is given to the environmental Sustainability. In the same line, Zabarburú et al. (2023) studied the sustainability and efficiency level of production of rainbow trout in Peru, and argued that all studied groups of trout operate at medium level of sustainability, however, most of them are in the technical inefficiency level.

CONCLUSION AND RECOMMENDATIONS

Factors that affect the cumulative knowledge and practical behaviors (CKPB) of camels' owners were found to be age, educational level, main job, training received, total cost of production and grazing behavior. Likewise, there is positive association between camel owners' level of cumulative knowledge and practical behavior and their level grazing behavior as an indicator of environmental sustainability. Thus in order to achieve high level of environmental sustainability, it is important to improve camels' owners' knowledge and practice level through adoption of modern methods of dissemination of information. This could be done through enhancing extension programs, providing veterinary services, building the capacity of workers in the camel sector, adopting extension programs to prevent overgrazing.

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Declaration

Authors declare no conflict of interest exists.

Authors' contributions

AIHI: Conceptualized and conducted the study, designed the questionnaire, data collection, conducted statistical analysis, wrote the manuscript, and revised the final version. MME: Conducted the literature review and wrote the introduction section participated in writing the result and discussion section and reviewed the final version. MAL: Participated in conceptualization and conduction the study, reviewed the manuscript. MES: Participated in statistical analysis. All authors have critically reviewed and approved the final draft, and are responsible for the content and similarity index of the manuscript.

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REFERENCES

Abbas, B., A. A. Al-Qarawi and A. Al-Hawas. 2000. Survey on camel husbandry in Qassim region, Saudi Arabia: Herding strategies, productivity and mortality. Rev. Elev. Méd. Vét. Pays Trop. 53: 293-298.

Abd El-Wahab, E. W., Y. Hegazy, W. F. El-Tras, A. Mikeal, A. F. Kapaby, M. Abdelfatah, M. Bruce and M. M. Eltholth. 2019. Knowledge, attitudes and practices (KAPs) and risk factors of brucellosis at the human-animal interface in the Nile Delta, Egypt. bioRxiv.

Abdallah, H. R. and B. Faye. 2013. Typology of camel farming system in Saudi Arabia. Emirates J. Food Agric. 25: 250-260.

Abdulla, S. H., A. Hajooj and A. Simir. 1998. Economic analysis of nomadic livestock operations in northern Saudi Arabia. In: V. R. Squires and A. E. Sidahmed (Eds.), Drylands: Sustainable Use of Rangelands into the Twenty-first Century. IFAD Series: Technical Reports. International Fund for Agricultural Development, Rome, pp. 375-383.

Abouheif, M. A., S. M. Basmaeil and M. N. Bakkar. 1990. A standard method for jointing camel carcasses with reference to the effect of slaughter age on carcass characteristics in Najdi camels. I. Wholesale cut weight. Asian-Australas. J. Anim. Sci. 3: 102-197.

Agab, H. 2002. Diseases and Causes of Mortality in a Camel (*Camelus dromedarius*) Dairy Farm in Saudi Arabia. Camel Project, Al-Qassim, Saudi Arabia. Available from: https://www.sustech.edu/staff_publications/20090614123209631.pdf

Ahmad, S., M. Yaqoob, N. Hashmi, S. Ahmad, M. A. Zaman and M. Tariq. 2010. Economic importance of camel: Unique alternative under crisis. Pak. Vet. J. 30: 2074-7764.

Ahmad, Y. 1998. The socio-economics of pastoralism: A commentary on changing techniques and strategies for livestock management. In: V. R. Squires and A. E. Sidahmed (Eds.), Drylands: Sustainable Use of Rangelands into the Twenty-first Century. IFAD Series: Technical Reports. International Fund for Agricultural Development, Rome, pp. 329-344.

Akudugu, M. A., E. Guo and S. K. Dadzie. 2012. Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? J. Biol. Agric. Healthc. 2: 1-14.

Al-Eknah, M. M., A. M. Homeida, R. O. Ramadan, F. A. Al-Modhi and K. A. Al-Busadah. 2001. Pregnancy dependence on ovarian progesteronein the camel (*Camelus dromedarius*). Emirates J. Agric. Sci. 13: 27-32.

Alemayehu, D. and Z. Doda. 2020. Indigenous Environmental knowledge of Borana pastoralists. Grassroots J. Nat. Res. 3: 110-131.

Al Humaidi, I. A. 1994. The Role of Rural Offices in Saudi Village Development in Qassim Region: An Evaluation Study. Ph.D. Thesis, University of Wales, Cardiff, U.K, p. 645.

Almadini, A. M., A. I. H. Ismail and F. A. Ameen. 2021. Assessment of farmers practices to date palm soil fertilization and its impact on productivity at Al-Hassa oasis of KSA. Saudi J. Biol. Sci. 28: 1451-1458.

Al-Mahish, M., R. M. Elzaki and N. K. Al-Qahtani. 2018. Demand and nutrients elasticities of camel meat: An analysis of kingdom of Saudi Arabia. Livest. Sci. 9: 140-150.

Al-Mutairi, S. E., I. Boujenane, A. Musaad and F. Awad-Acharari. 2010. Non-genetic factors influencing reproductive traits and calving weight in Saudi camels. Trop. Anim. Health Prod. 42:1087-1092.

Alshuaibi, A. and A. I. Ismail. 2013. Impacts of Agricultural Sector on the Domestic Field Consumption in KSA. Saudi ARAMCO in Collaboration with Department of Agribusiness and Consumer Sciences, College of Agricultural and Food Sciences, King Faisal University. Technical Report.

Al-Swailem, A. M., K. A. Al-Busadah, M. M. Shehata, I. O. Al-Anaziand and E. Askari. 2007. Classification of Saudi Arabian camel (*Camelus dromedarius*) subtypes based on RAPD technique. J. Food Agric. Environ. 5: 143-148.

AOAD. 2018. Arab Agricultural Statistics Yearbook-Vol 37. Arab Organization for Agricultural Development, Khartoum. Available from: https://www.aoad.org/assy37/statbook37cont.htm

Aziz, M., B. Faye, M. Al-Eknah and A. Musaad. 2016. Modeling lactation curve of Saudi camels using the linear and non-linear forms of the incomplete Gamma function. Small Rumin. Res. 137: 40-46.

Bayyurt, N. and S. Yilmaz. 2012. The impacts of governance and education on agricultural efficiency: An international analysis. Procedia Soc. Behav. Sci. 58: 1158-1165.

Bourn, D. 2003. Livestock Dynamics in the Arabian Peninsula. A Regional Review of National Livestock Resources and International Livestock Trade. Environmental Research Group Oxford Limited., U.K.

Cardellino, A. R. 2005. Status of the World's Livestock Genetic Resources. Preparation of the First Report on the State of the World's Animal Genetic Resources. In: Conference on the Role of Biotechnology, Villa Gualino, Turin, Italy 5-7 March, 2005, Animal Production and Health Division, the FAO, Rome, pp. 1-6.

Chatty, D. 1990. The current situation of the Bedouin in Syria, Jordan and Saudi Arabia and their prospects for the future. In: C. Salzman and J. G. Galaty (Eds.), Nomads in a Changing World. Istituto Universitario Orientale, Naples, pp. 123-138.

Duba, D. R. and J. Ellis. I978. Rangeland Vegetation and Livestock Resources in the Arabian Shield South: Inventory and Management. Unpublished Report to the Ministry of Agriculture and Water, Kingdom of Saudi Arabia.

FAO. 2022. Statistical Yearbook 2022. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FAO. 2007. Regional Report on Animal Genetic Resources: The Near and Middle East. Annex to The State of the World's Animal Genetic Resources for Food and Agriculture. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FAO. 2011. The Technical Cooperation between Kingdom of Saudi Arabia, Food, and Agriculture Organization of the United Nations (FAO). Achievements of the Technical Cooperation Programme Document Prepared by FAO Office in Riyadh Kingdom of Saudi Arabia. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

FAOSTAT. 2009. Available from: https://faostat.fao.org

Faye, B., H. Madani and S. A. H. El-Rouili. 2014. Camel milk value chain in Northern Saudi Arabia. Emirates J. Food Agric. 26: 359-365.

General Authority for Statistics. 2019. The Statistical Yearbook. Riyadh, KSA. Available from: https://www.stats.gov.sa/en/258

Kothowa, J. P., R. L. Mfune, J. Godfroid, B. M. Hang'Ombe, M. Simuunza and J. B. Muma. 2021. Documenting the absence of bovine brucellosis in dairy cattle herds in the Southern region of Malawi and the associated knowledge, attitudes and practices of farmers. J. S. Afr. Vet. Assoc. 92: a2130.

Ma, Y., B. Luo, Q. Zhu, D. Ma, Q. Wen, J. Feng and D. Xue. 2019. Changes in traditional ecological knowledge of forage plants in immigrant villages of Ningxia, China. J. Ethnobiol. Ethnomed. 15: 65.

Madalcho, A. B., B. A. Tadesse, K. Gebeyew and G. Gebresilassie. 2019. Camel feed characterization of Ethiopian Somali region

rangelands through traditional knowledge. J. Agric. Ecol. Res. Int. 19: 1-15.

Marshall, K., N. Mtimet, F. Wanyoike, N. Ndiwa and H. Ghebremariam. 2018. The traditional livestock breeding practices of women and men Somali pastoralists: Breeding management and beliefs on breeding issues. Anim. Prod. Sci. 59: 1568-1583.

Milewski, I. and R. E. Smith. 2019. Sustainable aquaculture in Canada: Lost in translation. Mar. Policy. 107: 103571.

Ministry of Environment, Water and Agriculture. 2020. Statistical Book 2020. Riyadh, KSA. Available from: https://www.mewa.gov.sa/ar/informationcenter/researchs/reports/generalreports/%d8%a7%d9%84%d9%83%d8%aa%d8%a7%d8%a8%20%d8%a7%d9%84%d8%a7%d9%95%d8%ad%d8%b5%d8%a7%d9%8a%d9%94%d9%8a%202020.pdf

Musallam, I. I., M. N. Abo-Shehada and J. Guitian. 2015. Knowledge, attitudes, and practices associated with brucellosis in livestock owners in Jordan. Am. J. Trop. Med. Hyg. 93: 1148-1155.

Palada, E., E. Alde and R. Delantar. 2020. Effect of training on knowledge level of farmers about commercial poultry and table egg production. Indian J. Sci. Technol. 13: 646-653.

Schwartz, H. J. 1992. Productive performance and productivity of dromedaries (*Camelus dromedarius*). Anim. Res. Dev. 35: 86-98.

Steinfeld, H., T. Wassenaar and S. Jutzi. 2006. Livestock production systems in developing countries: Status, drivers, trends. Rev. Sci. Tech. 25: 505-516.

The Global Economy. 2022. Saudi Arabia: GDP Share of Agriculture. Available from: https://www.theglobaleconomy.com/saudi-arabia/share_of_agriculture/#:~:text=saudi%20arabia%3a%20value%20added%20in,of%20gdp%2c%201968%20%2d%202020%3a&text=the%20latest%20value%20from%202020,146%20countries%20is%2010.81%20percent [Last accessed on 2022 Mar 14].

Zabarburú, R.C.M., Millones, C., Guadalupe, G.A., Idrogo-Vásquez, G., Chu-Koo, F.W., Fernández-Jeri, A.B., Gill, E., Chavez, S.G. and García, L. 2023. Integrating assessment of characterization, sustainability and efficiency for the production of rainbow trout (*Oncorhynchus mykiss*): A case study in the Amazonas region of Peru. Agriculture. 13: 1-17.