



Livestock Practices: Traditional Animal Holdings Classification in Qatar 2020 Towards Sustainable Food Security

Elmogiera Elawad^{1*}, Muzzamil Atta², Mohammed Agied³, Mohamed Ahmed⁴, Hussein Alyahri⁵, Mohamed Elbashir⁶

^{1,3}Social and Economic Survey Research Institute, Qatar University, P.O.B. 2713

²Ministry of Municipality, Qatar, P.O.B. 23211, University of Bahri, Sudan

^{4,6}Research Assistance, Qatar Agriculture Census 2021

⁵Ministry of Municipality, Qatar, P.O.B. 23211

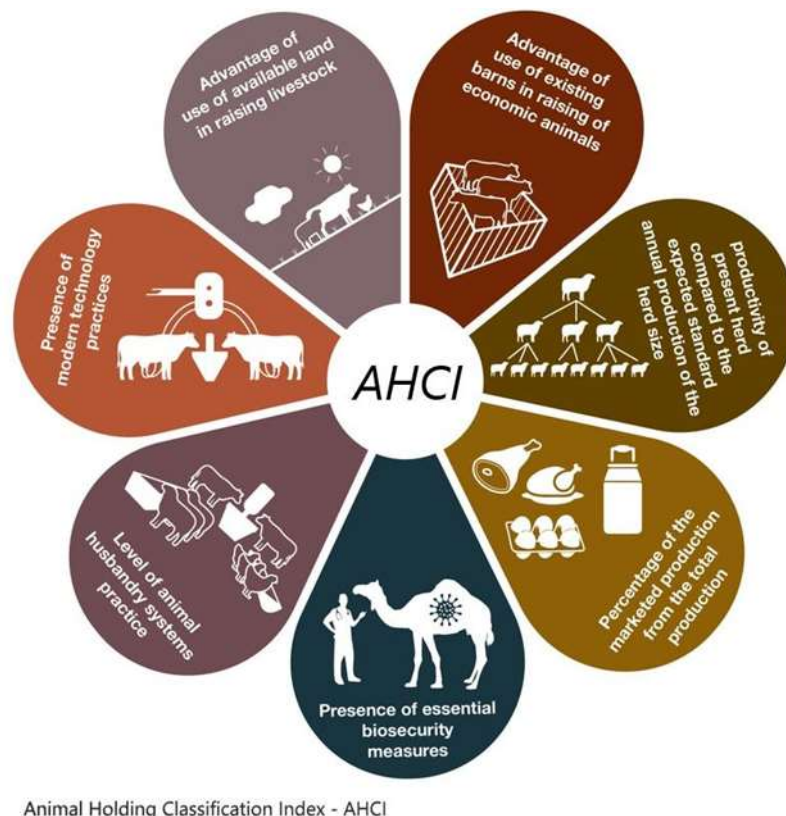
*Corresponding author's E-mail: elmogiera@qu.edu.qa

Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 18 Nov 2023	<p>Background: Traditional animal holdings (TAH) in Qatar face many managerial challenges, such as inadequate usage of land capacity, low levels of animal productivity and low economic returns. The top priority of the Ministry of Municipality strategy is to take care of TAH to ensure the sustainability of this activity and to maximize its role in national food security. To support future policy choices and services provision, the ministry initiated a TAH classification system. In 2020, the Social and Economic Survey Research Institute (SESRI) of Qatar University conducted a comprehensive agriculture census that followed a well-known methodology. The census form consisted of questions that guided the classification of TAH. The aim of this study is to help assess TAH performance using data from the census. Results: The Animals Holdings Classification Index (AHCI) divided the current holdings into one of five categories (A, B, C, D or E) in accordance with seven factors as classification criteria. These factors were levels of land and barn capacity utilization, livestock productivity, economic return, biosecurity measures, husbandry system and usage of technology for animal production. The results showed that most of the holdings fell into categories C and D. The lowest-scoring criteria were commitment to biosecurity measures and economic benefit. We recommended intensifying extension and enacting legislation to organize holdings to comply with biosecurity measures and initiating marketing programs and market outlets for TAH. According to Qatar's 2021 agriculture census, there are three different types of holdings: roving holdings (mobile), 33.6%; holdings in compounds, 57.6; and holdings outside rural houses, 8.8%. Conclusions: The AHCI not only determines a holding's actual productivity capability but also encourages holders to develop and upgrade their holdings. Furthermore, it helps the government fill gaps and provide services based on information and evidence.</p>
CC License CC-BY-NC-SA 4.0	Keywords: Animal Holding, Husbandry, Livestock, Agriculture Census

1. Introduction

Highlights

- The Animals Holdings Classification Index (AHCI) classified the current condition of animal holdings into five categories
- The animal husbandry system and biosecurity compliance represent criteria for animal holdings classification factors
- Most animal holdings in Qatar complied with the advantages of capacity usage of existing barns (B)



Background

According to the United Nations Food and Agriculture Organization [1], an agricultural holding is an economic unit of agricultural production under single management. It is land used fully or partly for production purposes without regard to title, legal form or size. Management of such a holding is exercised in the following ways: singly, by an individual or household; jointly, by two or more individuals or households; by a clan or tribe; or by a juridical person, such as a corporation, cooperative or government agency. According to the FAO [2], in many countries, agricultural holdings are divided into two categories: (i) holdings in the nonhousehold sector (commercial holdings) and (ii) holdings in the household sector (traditional holdings managed by households or physical persons). Holdings in the nonhousehold sector, also known as “commercial farms”, are market-oriented, operated by legal persons and have hired managers. Corporations and cooperative holdings are also included in this definition. In general, commercial farms are well organized, specialized, and large or medium-sized. They may be private governmental enterprises or may be operated by families or households. Holdings in the household sector are small non-market-oriented holdings operated by a civil (natural) person or group of civil (natural) persons. Usually, these holdings are traditional or sole proprietorships. Each country may have its own definition of traditional holdings according to the farm structure and local context. Atta [3] reported that livestock in Qatar are predominantly raised under the closed system, either in traditional holdings (household sector) or commercial farm market-oriented projects. He added that 95.4% of the national livestock herd was raised in the traditional sector, and only approximately 4.6% was raised on commercial farms.

The Global Agenda for Sustainable Livestock [4] noted that smallholder livestock systems and pastoralism play a key role in achieving sustainable development goals. Through continuous innovation and adaptation, these systems can efficiently respond to challenges such as climate change, environmental degradation and market access in an increasingly globalized economy. Similarly, Wong et al. [5] noted that smallholder livestock systems offer great potential for achieving sustainable development goals, and Tarawali [6] found that smallholder livestock farming is key to livelihood and food security and provides important environmental benefits. The International Fund for Agricultural Development [7] mentioned that for livestock keepers to benefit from the opportunities offered by the growing demand for livestock products, smallholder livestock production systems need to become more productive, efficient and environmentally sustainable.

Qatar, like all the countries of the Arabian Peninsula, is a semi-arid country that is challenged by water scarcity and limited pastures. These issues are the main challenges to the growth of Arabian Peninsula agriculture [8]. Moreover, Karanisa et al. [9] showed that Qatar’s average annual temperature has risen

by 0.3 °C over the past 40 years and is expected to continue to increase. This will likely reduce the production of both crop and livestock agriculture.

The state of Qatar pays close attention to the agricultural sector and food security with the aim of achieving the Qatar Vision 2030 goals. The Qatar National Food Security Strategy (2018–2023) is based on five main pillars, including local self-sufficiency [10] in the various agricultural fields – plants, animals and fish. During 2020–2021, the agricultural sector made clear steps towards achieving food security, increasing agricultural production, and improving self-sufficiency in agricultural products such as green fodder, dairy, chicken and red meat.

It is in the state’s interest to monitor and evaluate plant and animal holdings to upgrade and develop these holdings, enabling them to play an important role in food security. TAH classification plays an important role in evaluation and monitoring, which are followed by policies and plans for providing services, subsidies and extensions.

2. Materials and Methods

A The comprehensive agricultural census was conducted following the standard approach of the FAO. The census data collection was carried out between December 2020 and April 2021. The statistical program Blaise was used for computer-assisted personal interviewing (CAPI); the program was equipped with applications to measure the areas of livestock holdings and barns.

Data collection and tools

The enumerator, who was a veterinarian, inspected each holding and took the required measurements and obtained the relevant answers to the questionnaire from the owner of the holding or the responsible manager.

The census questionnaire contained questions related to the presence of the classification factors in animal holdings, starting with the area of the holding and the barns, counting the number of animal resources, and other topics, such as

- Annual productivity and marketing of products
- Biosecurity assessment
- Applied management measures
- Practised husbandry system
- Availability of environmentally friendly facilities

Trained enumerators started the data collection on January 5, 2021, and the survey ended on March 30, 2021. Fifty enumerators with 10 field supervisors conducted the data collection. All the information was entered into a laptop which included an application to measure holding and barn areas.

Animal holding classification factor weights

According to the Animal Resources Department [17], the weight of each factor differs according to the components of each factor (Table 4).

Table 4. Score factors of animal holdings classification.

No.	Factor	Full score
1	Advantages of available land for raising livestock (L)	20
2	Advantages of usage of capacity of existing barns for economic animal husbandry (B)	15
3	Ratio of actual productivity of animals to the standard annual production of the existing animals (P)	10
4	Economic benefits of the holding production (E)	15
5	Biosecurity compliance (S)	15
6	Animal husbandry system (H)	10
7	General condition of the estate and utilization of modern technology in production processes (T)	15
	Total	100

Types of animal holdings in Qatar

According to Atta [3], TAH were classified according to the type of ownership as follows:

- 1- Small farms: Landownership is private. The source of drinking water is the farm's well. The integrated agriculture and livestock system, in the accepted sense as the presence of free animals in a pasture on a regular basis, is not practised. Most of the agricultural land is used for the production of vegetables or fodder for the central market. Agricultural by-products may be used as animal feed.
- 2- Holdings in compounds (locally known as Ezab compounds): For these holdings collected in compounds, landownership is governmental. Each holding has a limited area, usually not more than 2500 square metres (50 m x 50 m). Animal feed and drinking water are brought in from outside the holding. There are 9 Ezab compounds in the country. In addition to these compounds, there is a special compound (Al – Race) that was established to raise racing camels. Most animals in this compound are camels used for racing, training and exhibition.
- 3- Roving holdings (locally named roving Ezabs): These are mobile animal holdings on governmental land in open area(s).
- 4- Outside planning Ezab holdings are extension(s) of a rural house (IZBAH outside a rural house) or a farm (IZBAH outside planning of a farm). The land is governmental, adjacent to a rural house or farm.
- 5- Other holdings that are single barns or chalets under private ownership.

It is noteworthy that temporary holdings were established in the Al-Nakhsh district (near the border with the Kingdom of Saudi Arabia) in 2017 as a result of the return of Qatari animal resources from Saudi Arabia during the blockade crisis.

Animal holding classification

The Committee of Farms and the Regulation of Farmers Affairs of the Ministry of Municipality [17] approved the animal holdings classification mechanism, although it is not the same as that used by the FAO [18], based on the assessment of seven factors:

1. Benefiting from the available land for livestock raising. This axis was evaluated by the ratio of the barn area to the total holding area [19].
2. The advantage of using these barns in raising animal resources. This factor was evaluated by rating the proportion of the present herd size to the optimum capacity of the barn area [20-22].
3. The level of actual productivity of the present herd compared to the expected standard annual production of the herd size [21, 23, 24].
4. The economic benefit of this production, which is indicated by the proportion of the marketed production to the total holding production [18].
5. The degree of concern for the holding's environment safety and reducing the risk of animal exposure to pathogens according to the fulfilment of biosecurity measures in holdings [19, 25].
6. The application of a sound animal husbandry system and the level follow-up in the presence of well-defined recording systems [18, 19, 25].
7. The general state of the holding and benefit from scientific development and modern technology in production [18].

Calculations of factors, scores and index

There are two steps to calculate the AHCI. Step one is to estimate the factors. Any factors including more than one component are calculated by totalling the scores of the components.

$$\text{Factors} = f(x) = \sum_j^i (c_{ij})$$

Component (c_{ij}) calculated directly from census data,

$$\text{AHCI} = \sum_j^i (f_{ij})$$

The AHCI was calculated by summing the scores of the seven factors.

$$\text{HCI} = \sum_j^i (L + B + P + E + S + H + T)$$

L, B, P, E, S, H and T (see Table 2) are the classification factors. The seven-factor calculation is shown in the equations below:

Advantages of available land for raising livestock (ratio of barn area to total area of holding, L)

$$L = 100 \times \frac{\text{total area of barns}}{\text{total area of the holding}}$$

Advantages of usage of the capacity of existing barns in economic animal accommodation (B):

The average standard capacity of the available barn area is 2 m²/head for sheep and goats, 30 m²/head for cattle and 30 m²/head for camels.

B= the average of B for sheep and goats, camels and goats

$$B \text{ for sheep and goats} = 100 \times \frac{\text{Number of sheep and goats}}{(\text{Sheep and goat barn area}/2)}$$

$$B \text{ for camels} = 100 \times \frac{\text{Number of camels}}{(\text{Camel barn area}/30)}$$

$$B \text{ for cattle} = 100 \times \frac{\text{Number of cattle}}{(\text{cattle barn area}/20)}$$

The ratio of the actual productivity of animals to the standard annual production of the existing animals (P). This score is the average of the scores of each livestock type (sheep and goats together, cattle and camels). The score of the ratio of the actual productivity of each livestock type (P) is calculated by the following equation:

$$P = 100 \times \frac{\text{Number of of new born animals (birhs and weaned)}}{\text{standard annual production of present adult females (SAP)}}$$

The standard annual production (SAP) of females present on a holding was calculated as follows:

$$\text{SAP of sheep and goats} = 0.8 \times 1 \times \text{Number of adult female ewes and does}$$

$$\text{SAP of cattle} = 0.8 \times 0.5 \times \text{Number of adult cows}$$

$$\text{SAP of camels} = 0.8 \times 0.3 \times \text{Number of adult female camels}$$

Economic benefits of farm production (E): This factor is the average of the marketing scores of local poultry (Baladi), eggs, milk and live animals. The marketing scores are calculated as follows:

$$\text{Local poultry marketing rate} = 100 \times \frac{\text{Number of local poultry marketed per day}}{\text{Area of shed for local poultry} \times 7}$$

$$\text{Egg marketing rate} = 100 \times \frac{\text{Number of trays of eggs marketed per day}}{30 \times \text{local poultry shed area} \times 7}$$

Milk marketing rate
= 100

$$\times \frac{\text{Number of liters of milk marketed per day}}{\text{Number of adult ewes \& does } (0.8 \times 0.6 \times 0.75) + \text{number of adult cows } (0.8 \times 0.6 \times 12) + \text{number of adult female camels } (0.8 \times 0.6 \times 8)}$$

$$\text{Annual marketing rate for camels} = 100 \times \frac{\text{Number of camels marketed per year}}{\text{Number of current camels of offspring}}$$

$$\text{Annual marketing rate for cattle} = 100 \times \frac{\text{Number of cattle marketed per year}}{\text{Number of current cattle of offspring}}$$

$$\begin{aligned} \text{Annual marketing rate for sheep and goats} \\ = 100 \times \frac{\text{Number of sheep and goats marketed per year}}{\text{Number of current sheep and goat of offspring}} \end{aligned}$$

Biosecurity compliance (S)

$$\begin{aligned} S = & (\text{Presence of isolation barn} \times 3 + \text{presence of dung dump} \times 3 \\ & + \text{use of dung recycling technology} \times 3 + \text{presence of disinfection pools} \times 3 \\ & + \text{appropriate spacing between barns} \times 3) \end{aligned}$$

Applying an animal husbandry system (H) is the sum of 2 components:

- 1- Holding management system (HMS) score:

$$\text{HMS} = \text{specialized recording system} \times 2 + \text{specialized technician} \times 3)$$

- 2- The animal husbandry system score is the average of the scores of the cattle and camel herd raising system, sheep and goat flock raising system, and sheep and poultry raising systems. The score would be outstanding (5), if the herds were managed, housed and fed in groups according to type, age, and physiological and production stages; the score would be intermediate (3) if the herds were managed in groups divided only by type without taking into account the age,

physiological or production stages; and the score would be bad (2) if the management of the herd was random with no consideration of types, ages, or physiological and production stages.

The general condition of the estate and the utilization of modern technology in the production process (T).

This factor is composed of 6 components:

- 1- Suitable number of labourers for the animal unit: The number of labourers is considered suitable, scoring 2 if there is one or more person/5 animal units. The score is 1 if the number of animal units per person is more than 5. Animal units are calculated as follows:

$$\text{Animal units} = \text{number of cattle} \times 0.7 + \text{number of camels} \times 1 + \text{number of sheep and goats} \times 0.2$$

- 2- Suitable labourer accommodation: Labourer accommodation is considered suitable, scoring 2, if the labourer housing area is 6 m² or more per labourer and scores 1 if the area available per person is less than that. The score is zero if there is no specific building for labourer accommodation.
- 3- Presence of suitable input stores: The score is 3 if the stores are divided so that green fodder, concentrated feed and equipment are stored separately. The score is 1 if the fodder, feed and equipment are stored randomly in one storage area. The score is zero if there is no specific building for storage.
- 4- General layout of holding facilities: The layout of the holding is outstanding, scoring 3, if it takes into account the good division of barns and appropriate passages for the ease of flow of the daily operations of care, with adherence to the requirements of biosecurity in the distribution of facilities and the passage between them (for example, there is no intersection between clean green components and red components that can be polluted). It is intermediate, scoring 2, if the facilities are coordinated with good passages in between but with the random distribution of components without regard for the requirements of biosecurity. It is considered bad, scoring 1, if the division is random and does not take into account the presence of appropriate passages for the flow of daily production operations.
- 5- General cleanliness of the barns: The cleanliness is outstanding, scoring 3, if the barns are clean and there is indication of daily removal of litter. It is intermediate, scoring 2, if the barns are not clean, but there is no accumulation of dung and litter on the floor. The score is 1 if the status of the barns is bad and there is an accumulation of dung and litter on the floor.
- 6- The presence of environmentally friendly technologies (score 2), such as solar equipment (score 1) and a dung recycling unit (score 1).

AHCI categories

There are 5 AHCI categories: E, D, C, B and A. The E category represents empty and neglected holdings, which obtain a score of zero (0) in the AHCI. The D class is for holdings with a total AHCI score between 1 and 49 from the seven-factor assessment. The C class is an AHCI score between 50 and 59, and the B class is between 60 and 69. Finally, class A is for holdings that have an AHCI score of 70 or above.

3. Results and Discussion

According to the agriculture census report (2022), there are 6815 working animal holdings of different types; however, this study focused on only three types of holdings, roving, compound and outside rural houses, which represented 73% of animal holdings in Qatar. Table 1 shows the distributions of these holdings. The data show that 57.6% of these holdings are in compounds while 33.6% of them, just over one-third, are roving and only 8% are outside rural houses.

Table 1. Type of animal holdings – Qatar Agriculture Census 2021.

Holding Type	Number of Animals	%
Roving holdings (mobile)	1843	33.6
Holdings in compounds	3162	57.6
Holdings outside rural houses	481	8.8
Total	5486	100

Figure 1 presents the mean obtained score compared to the full possible score of each classification factor for the entire studied sample. The results show that the biosecurity (S) mean of the obtained score was 6 out of 15, which is the lowest value among all the factor means, while the general condition of the estate (T) mean score was 11 out of 15, which is the highest value among the factor means [11].

Figure legends

Figure 1. Mean of classification factors – agriculture census 2021.

Figure 2. Histogram of normality curves of classification categories.

Figure 3. Classification ratios in each type of animal holdings.

Figures

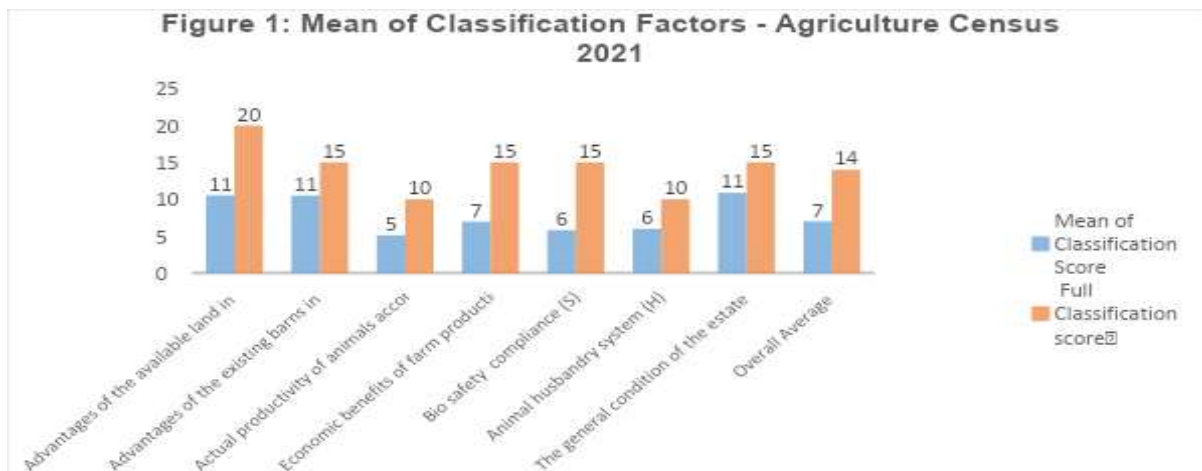


Figure 1

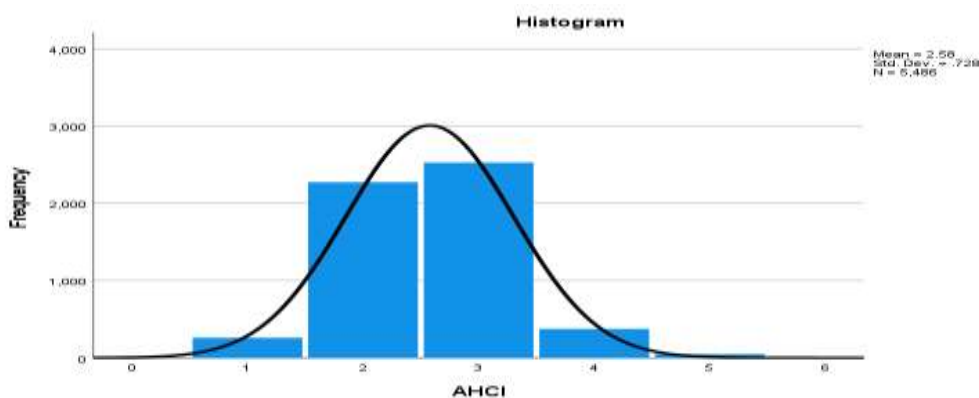


Figure 2

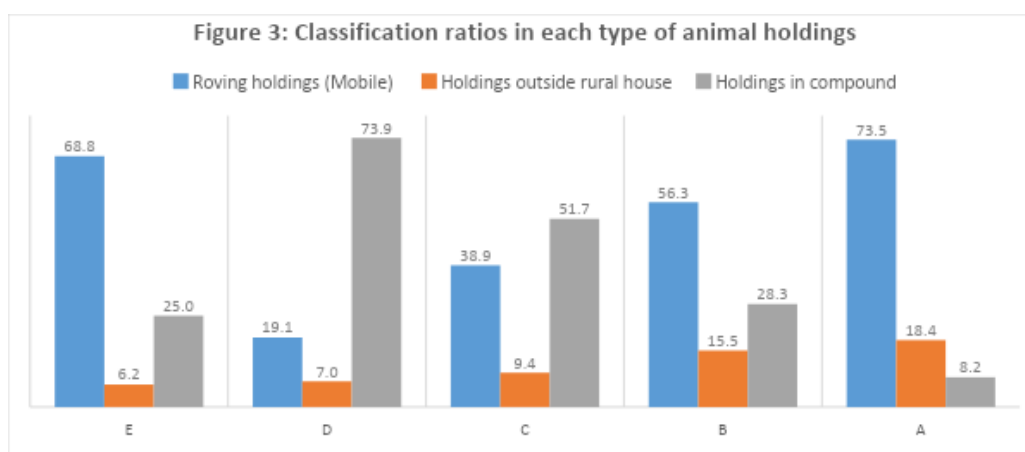


Figure 3

Table 2 shows the ratio of the average obtained score to the total possible score. This ratio indicates the performance of the holdings in each factor, providing a comprehensive picture of the classification factors that will help in the future in creating integrated plans and policies for improvement and development.

Table 2. Ratio of the mean obtained to the full score of the factors.

Factors	Ratio of the mean to the possible full score
General condition of the estate and the utilization of modern technology in the production process (T)	72%
Advantages of capacity usage of existing barns for economic animal accommodation (B)	70%
Animal husbandry system (H)	60%
Advantages of available land in raising livestock (L)	53%
Actual productivity of animals according to the expected annual production (P)	51%
Economic benefits of farm production (E)	46%
Biosecurity compliance (S)	39%

The data show that the highest average score achieved by animal holdings was for the factor of the general condition of the estate and the utilization of modern technology in the production process (T), 72%, followed by the factor of advantages of usage of capacity of existing barns in economic animal accommodation (B), 70%, while the economic benefits of farm production (E) and biosecurity compliance (S) achieved 46% and 39%, respectively.

Classification score categories

Referring to the AHCI results, 260 holdings (4.7%) were in the E class and 2274 (41.5%) were in the D class, while 2528 (46.1%) were in the C class. The holdings ranked as B and A together represented less than 8% of the assessed holdings, with 6.8% receiving the B classification and less than 1% (0.9%) in the A class (49 holdings). Table 3 shows the frequencies of the classification categories. Figure 2 shows the histogram of the normality curve of the classification categories (1=E, 2=D, 3=C, 4=B, A=1).

Table 3. Animal holdings classification index (AHCI).

Categories	Frequency	Percent
E	260	4.7
D	2274	41.5
C	2528	46.1
B	375	6.8
A	49	0.9
Total	5486	100.0

Figure 3 shows the classification of holdings by type of holding. Most in category A are roving holdings (73.5%), while 18.4% are holdings outside rural houses and only 8.2% are holdings in compounds. For holdings in category B, roving holdings represent 56.3%, those in compounds are 28.3% and those outside rural houses are 15.5%. The figure also shows that 51.7% of category C are holdings in compounds, while this type of holding represents 73.9% (3 out of four) in category D. The data also indicate that most (68.8%) of the neglected holdings (category E) are roving holdings [11].

Three decades ago, overgrazing and harsh environmental conditions severely damaged Qatar's rangelands. In 2011, a law was enacted prohibiting livestock grazing in the wild areas of Qatar. The state of Qatar implemented this law to preserve the environment by protecting wildlife and vegetation cover. Livestock grazing was threatening plants that grew in the desert in addition to the small oases. The government provided services to livestock owners, including barns and veterinary services as well as fodder, as an alternative to grazing. These services are linked to the holders' commitment to the relevant standards. The concerned government department benefits from this classification by distributing services based on the ranking of a holding in the classification. This classification of livestock holdings will help the government provide holding owners with services and support the government policy of preserving the natural environment in Qatar.

The agricultural sector faces challenges, including weather, water scarcity and the provision of fodder, in addition to problems related to the management of holdings. "According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), the average world temperature will increase between 0.6 and 2.5 degrees Celsius by 2060" [12-14]. We find that compliance with the standards of highly rated animal holdings (A and B), such as economic return and biosafety, requires effort from the owners of these holdings and the concerned government department to provide them with the necessary guidance.

We found that holdings outside rural houses and roving holdings have higher chances of obtaining a high rating, which may be due to the spaces available for the holding itself or barns in addition to increased interest and care by livestock owners.

We found that owners of holdings within compounds are less committed to the factor standard criteria, which may be due to the spaces or the lack of desire for economic returns, as some livestock owners tend to these holdings for social reasons. These results certainly require further studies on livestock holdings in Qatar to identify challenges and suggest solutions.

4. Conclusion

Livestock provides food such as meat, dairy products and their derivatives in addition to being important in Qatar for social reasons. Therefore, it represents a key factor of any food security strategy and planning. Qatar's agriculture census of 2021 accurately determined the national livestock herd's size, age and sex composition, dynamics and area of distribution in the country. The census data also provided an animal holdings classification according to the standards of livestock management, which are based on the specifications of international organizations and researchers interested in this sector. This classification will help concerned departments identify and prioritize services provided to producers and consumers.

We found that most animal holdings fall into two categories, C and D, which means that they need attention and guidance in many aspects to make them productive and more biologically secure. Very few holdings rated as categories A or B representing approximately 7% of the total holdings. Most of these holdings were roving holdings and holdings outside rural houses.

We found that the classified holdings scored a high rating in the general condition of the estate and the utilization of modern technology and advantages of usage of the capacity of existing barns in economic animal accommodation. The data also show that the lowest score was observed for the economic benefits of a holding's production and biosecurity measure compliance.

A variety of methods can be used to enhance the animal holdings scoring rate and thus the profitability of the holdings and sustainability of livestock production. Some of these methods include improving market access, regulations, and governance as well as making better use of technology [15].

As mentioned by MacKenzie [16], practising biosecurity in farms is important for the sustainability of animal health and the well-being of the society dealing with these animals. He added that simple methods can be used to create a safe farm environment and reduce the chance of exposing animals to disease agents or stress.

Recommendations

The recommendations that should be considered based on the study observations are as follows:

- Creation of marketing initiatives that encourage animal farmers to follow economic animal resource-raising practices.
- Intensification of extension and training services to farmers and workers to raise their awareness of the importance of compliance with biosecurity measures.
- Enacting the necessary legislation for holdings organization that ensures compliance with the standard biosecurity measure

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable.

Competing interests: All authors declare that there is no conflict of interest.

Funding: Qatar University

Authors' contributions: All authors read and approved the final manuscript.

Acknowledgements: Not applicable.

References:

1. FAO. Programme for the world census of agriculture 2000, FAO statistical development series No. 5. Rome, Italy: FAO; 1995.
2. FAO. Guidelines on methods for estimating livestock production and productivity. Publication prepared in the framework of the global strategy to improve agricultural and rural statistics. Rome, Italy: FAO; 2018.
3. Atta M. Contribution of livestock national herd to food security in Qatar. In: First international conference on sustainable development achieving food security in arid environments. College of Arts and Sciences, Qatar University; 2016.

4. GASL. Smallholder livestock systems innovations for sustainability, a policy brief from the NGO cluster of the global agenda for sustainable livestock. Manhattan, Kansas, US: Global Agenda for Sustainable Livestock; 2019.
5. Wong JT, de Bruyn J, Bagnol B, Grieve H, Li M, Pym R, Alders RG. Small-scale poultry and food security in resource-poor settings: a review. *Glob Food Secur.* 2017;15:43-52.
6. Tarawali S. The role of livestock in achieving the SDGs. In: 16th annual general meeting of the inter-agency donor group on pro-poor-livestock research and development GIZ Berlin, 18 to 20 November 2015 ILRI presentation. 2015.
7. IFAD. Scaling up note: smallholder livestock development. Rome, Italy: IFAD; 2015.
8. Dhehibi B, Nejatian A, Niane AA, Belgacem AO. Factors influencing adoption of rangeland rehabilitation technologies by agro pastoralists in the arabian peninsula: Evidence from analysis in Saudi Arabia and Qatar. Beirut, Lebanon: International Center for Agricultural Research in the Dry Areas (ICARDA); 2021.
9. Karanisa T, Amato A, Richer R, Abdul Majid S, Skelhorn C, Sayadi S. Agricultural production in Qatar's hot arid climate. *Sustainability.* 2021;13:4059.
10. Almari M. Statement in ministry of municipality website in the occasion of the world food day. 2021. www.mme.gov.qa. Accessed 16 Oct 2021.
11. Qatar Agriculture Census. 2020.
12. Kristvik, Muthanna, Alfredsen. 2019.
13. Wei et al. 2014.
14. Savari M, Zhoolideh M. The role of climate change adaptation of small-scale farmers on the households food security level in the west of Iran. *Dev Pract.* 2021;31:650-64.
15. Jones M. Commissioning editor, the world economic forum agenda. 2015. <https://www.weforum.org/agenda/2015/06/8-ways-africa-can-raise-farm-productivity-and-boost-growth/>.
16. MacKenzie MK. Five simple steps to improve biosecurity around livestock. Cornell Small Farms. 2019. <https://smallfarms.cornell.edu/2019/06/five-simple-steps-to-improve-biosecurity-around-livestock/>. Accessed 9 Feb 2022.
17. Committee of Farms and the Regulation of Farmers Affairs. محضر اجتماع اللجنة الدائمة للمزارع وتنظيم شؤون المزارع. 24/10/2018. رقم (11) لسنة 2018 المنعقد بتاريخ 2018.
18. Abu Shaye AS, Atta M. مقترح تصنيف العزب. ارشيف تقارير إدارة الثروة الحيوانية. 2018
19. DAR. Basic technical requirements for animal production projects. Documentation of procedures for the implementation of animal production projects. Archive of Department of Department of Animal Resources (7-50267-2012). 2012.
20. Acsad. دليل ابواء المجترات الصغيرة في المناطق الجافة وشبه الجافة في الدول العربية. المركز العربي لدراسات المناطق الجافة والااضي. 2440 acsad_report_on_animal_successes.pdf (uneswa.org). 2015.
21. Phipps G, Salkeld J, Walker B. Husbandry guidelines for Arabian Camel *Camelus dromedarius*. Richmond: Western Sydney Institute of TAFE; 2009.
22. Hall JM, Sansoucy R. Open yard housing for young cattle. FAO animal production and health paper 16. Rome, Italy: FAO; 1981.
23. Zarkawi M. Monitoring the reproductive performance in Awassi Ewes using progesterone radioimmunoassay. *Small Rumin Res.* 1997;26:291-4.
24. Al-Marri SJ, Atta M. SWOT analysis for small ruminants' production in the State of Qatar. The second regular meeting of officials and experts of researches and technology transfer in the field of animal production under the title of "improving the breeds of small ruminants in the Arab World" in Khartoum on May 27 to 29/2014. 2014.
25. MSD. Principles of biosecurity of animals, The MSD veterinary manual. Kenilworth, NJ, USA: Merck & Co., Inc.; 2019.