

Assessment of livestock breeder's attitude towards the use of compound feed in the Kingdom of Saudi Arabia

M.H. Al-Mutairi^{1*}, K.H. Al-Zahrani², H.S. Qassem²

¹Department of Animal Feed, Saudi Food and Drug Authority, 4904 northern ring branch rd Hittin Dist Unit number: 1 Riyadh 13513 – 7148; ² Department of Agricultural Extension and Rural Community, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia

*Corresponding author: mh.mutairi@sFDA.gov.sa

Journal of Livestock Science (ISSN online 2277-6214) 14: 308-316
Received on 20/9/23; Accepted on 5/11/23; Published on 25/11/23
doi. 10.33259/JLivestSci.2023.308-316

Abstract

The importance of the study lies in the fact that feed has a direct impact on animal and human health. The failure of breeders to use healthy and suitable fodder for the animal that meets the nutritional needs is due to several reasons, including the culture and education of the breeder, and some reasons related to the fodder itself, such as being of lower quality that does not meet the animal's nutritional and productive needs. The main objective of the study is to identify the feeding practices followed by livestock breeders, to assess their attitudes towards compound feed, and to determine the relationship between the personal and social characteristics of the breeders and their attitudes towards compound feed. The descriptive method was used. This study was conducted on livestock breeders in the Saudi Arabia, whose number is about (901,108 breeders). The questionnaire was used as a means of data collection, and (442) completed questionnaires representing the study sample were obtained. Descriptive statistical analyzes were used, and the chi-square test was used to measure the relationship between the personal and social characteristics of breeders and their attitudes towards compound feed. The analysis was done using the SPSS, v.26). The results of the study revealed that 52.5% of livestock breeders do not use compound feed in feeding livestock. The study also showed that 62.9% of livestock breeders did not notice the emergence of health problems in their livestock when using compound feed, while 37.1% noticed several problems, including: changing the color of the meat, disease, problems in milk production, diarrhea, and abscesses. ...etc.) when using compound feed, as it was found that the vast majority of livestock breeders, by 86.4%, had a neutral attitude towards compound feed. Finally, a significant relationship was found between the gender variable, the number of years of experience, and the feeding system variable with the breeders' attitudes towards the use of compound feed.

Keywords: livestock breeders; Compound feed; Feeding system; animal production

Introduction

Livestock plays an important role in food security, as the demand for animal products has increased globally as a result of the increase in population, improved income, and expansion of urbanization. Also, by the year 2050, the demand in middle- and low-income countries will increase to 455 million tons of meat and 1,077 million tons of dairy more than in 2005 and 2007 (Alexandratos and Bruinsma, 2012). Animal food affects production, profits, the environment, as well as human food security and health, and animal nutrition represents about 70% of animal production costs (Makkar, 2016). Good nutrition increases animal production efficiency and thus profits (Linde *et al.*, 2002). There are various animal production systems that are developing rapidly to meet the growing and sustainable demand for animal products. These systems focus on recent trends in maintaining a balance between intensifying livestock production and ensuring the livelihoods of families that depend on it, and applying best practices for more sustainable livestock management (Robinson *et al.*, 2011; FAO, 2016).

The Codex Alimentarius Commission (Codex) has issued a guide to good animal nutrition that sets out the basic principles of good animal feeding practices at any stage of the feed chain, from feed producers to animal nutrition by breeders (Codex Alimentarius, 2004). Nutrition systems are one of the most important practices that affect production, profits, the environment, as well as human food security and health (Makkar, 2016). In general, there are two systems for feeding animals, the first of which is traditional feeding, either by grazing or feeding the animal on grains and green or rough fodder, together or separately, such as feeding on barley and clover. The second is modern feeding with compound feed, which are homogeneous mixtures of raw feed materials prepared from plant sources, mineral salts and vitamins in certain proportions with other feed additives such as mixtures of fatty acids and oils. They are generally produced either in a soft form or in the form of pellets or granules (Saudi Food and Drug Authority, 2017). The use of integrated and appropriate feed for the animal that meets the nutritional needs is linked to several reasons, including the personal and social characteristics of the breeders. There are also some reasons related to the feed itself, such as its poor quality that does not meet the animal's nutritional and productive needs, or the feed factories' use of poor-quality feed inputs (Ministry of Environment, Water and Agriculture, 2020).

The problem of the study lies in the crisis resulting from the shortage of barley supplies, and the increase in its prices after the removal of government support for it in the Kingdom of Saudi Arabia in accordance with the decision of the Ministry of Environment, Water and Agriculture No. (1441/1/291035) dated December 21, 2019 (Ministry of Environment, Water and Agriculture, 2019). As well as stopping the cultivation of green fodder by Cabinet Resolution No. 66 dated 8 December 2015 (Council of Ministers, 2015). And the need to switch from traditional feed (barley and alfalfa) to compound feed that will contribute to raising the efficiency of animal production. In the absence of previous studies in the Kingdom of Saudi Arabia on the current situation of livestock breeders' attitudes towards compound feed and the problems they face in this regard.

The main objective of the study is to analyze the attitudes of livestock breeders towards compound feed. This objective will be achieved through the following sub-objectives: 1- Exploring livestock breeders' attitudes towards compound feed. 2- Determining the relationship between the personal and social characteristics of livestock breeders and their attitudes towards compound feed. 3- Determining the relationship between the feeding system followed and the attitudes of livestock breeders towards the use of compound feed.

Methodology

Survey Design

The research strategy adopted by this study is a quantitative research methodology using a survey design. A cross-sectional survey design was used to collect data at one point in time and examine the patterns of relationship between various variables at a particular time.

Study Population and Sample

The population of the study consisted of livestock breeders in Saudi Arabia. Their information was obtained from the Ministry of Environment, Water, and Agriculture (MEWA) database. As of December 31, 2021, the number of the registered livestock breeders in the database was 108,901 breeders (Ministry of Environment, Water and Agriculture, 2021). An online survey was developed to collect data from January to March 2022. The e-questionnaires were shared with all livestock breeders in the database through an e-mail and WhatsApp message. The researchers prepared an information sheet that included the purpose of the study and the researchers' contact information. Livestock breeders were given one month to fill in the e-questionnaire, and 281 questionnaires were delivered without any reminders. A reminder was then sent to all non-responding breeders after this period. After this reminder, two weeks were given to complete the e-

questionnaire. During this period, another 131 questionnaires were collected. The researchers sent a final reminder to all non-responding breeders, giving them another two weeks to complete the e-questionnaires. In this period, 116 responses were collected. A total of 528 responses were returned to the researchers. Eighty-six questionnaires were excluded due to incomplete data. Accordingly, in the final analysis, the total sample consisted of 442 breeders.

Data collection tool

The questionnaire consists of two sections. The first section consists of the following information about the livestock breeders' profile: gender, age, education, primary source of income, experience in livestock farming, membership in livestock associations, extension contact, primary purpose of livestock farming, number of farm animals, type of livestock operation and system. nutrition. breeders were asked to rate the dependence of each trend on a five-point Likert scale (strongly agree = 5, agree = 4, neutral = 3, disagree = 2, strongly disagree = 1). The livestock breeders' attitudes index included 13 items. Each item on the scale represents a widely recommended practice at the micro (farm) level.

The overall scale score was calculated by summing their ratings and converting them to a percentage. The total score for each trend was divided into three groups based on the average score as follows: high level (>75%), medium level (50%-75%), and low level (<50%). To test the stability of the livestock breeders' attitudes scale, the internal consistency method was used by calculating Cronbach's alpha coefficient. The Cronbach's alpha score for livestock breeders' attitudes was 76.0. This value was higher than the accepted internal consistency value (>0.7%), which indicates good internal consistency and high stability of the scale and its subscales.

To ensure the validity of the tool's content, each item in the feed safety scale was activated and measured based on the definitions and clarifications contained in the feed legislation issued by the Food and Drug Authority and the IFIF and FAO guides on good practices in the feed sector. Moreover, each item was examined on the basis of its suitability for the purpose of the study by five experts from the Department of Animal Production at King Saud University.

Additionally, pre-testing the tool with 15 livestock breeders prior to data collection ensures that the content is valid. Six items were reformulated to reflect the local farming context in Saudi Arabia, according to responses from breeders who participated in the pre-test. Not all breeders participating in the pilot study were included in the sampling process. Accordingly, the livestock breeders' attitudes scale proposed for the study reached the established standards of validity and content reliability. Ethical approval was obtained from the Human Ethics Committee of King Saud University (Ref. No. HEC 2021/758) to conduct this study.

Data analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS, version 28.0, IBM Corp, Armonk, NY, USA.). Responses were reported using descriptive statistics methods such as frequency distributions, percentages, and arithmetic mean. Similarities and differences between the trends examined in relation to the average adoption score were explored using hierarchical agglomerative cluster analysis. Euclidean distance was applied as a measure of divergence, and Ward's hierarchical clustering method was used for the trends of the livestock breeders under study.

The *Mann-Whitney* test is then performed to determine statistically significant differences between the two groups identified from the cluster analysis. Moreover, the chi-square test of independence test was used to examine the differences between the two clusters regarding breeders' profiles and farm characteristics. The results of cluster analysis were graphically presented; the heatmap and a dendrogram, using Origin (ver. 2; OriginLap Corp., Northampton, MA, USA).

Results

Socioeconomic Characteristics of the Respondents

Table 1 shows the socioeconomic profile of the surveyed livestock breeders. The findings reveal that more than half of the respondents (58.9%) were male, whereas 41.1% were female. The mean age of livestock breeders was 39.11 years. On average, the respondents had 9.8 years of education. Furthermore, livestock rearing was the main occupation of the majority of the breeders (83%). Most of the breeders (55.9%) had less than 16 years of experience in raising livestock.

Only a small proportion of the respondents (9.1%) were members of the local livestock association, and approximately a third of them (32.5%) had regular contact with extension workers. Additionally, commercial production was the main purpose for raising livestock for 62.4% of the sample. Regarding the farm characteristics, Table 1 also shows that breeders owned and managed more than one type of animal.

Table 1. Socioeconomic profile of the respondents.

breeders Characteristics	Freq.	%	Mean	Std. dev.	Min.	Max.
Gender (n = 440)						
Female	181	41.1	0.59	0.49	0	1
Male	259	58.9				
Age (n = 402)						
Less than 35 years	195	48.5	39.11	12.66	22	90
35–55 years	159	39.6				
More than 55 years	48	11.9				
Education (n = 442)						
Illiterate	61	13.8	9.8	4.9	0	17
Less than 7 years	84	19.0				
7–12 years	189	57.8				
More than 12 years	105	24.4				
Livestock farming as a main source of income (n = 442)						
Yes	367	83	0.83	0.37	0	1
No	75	17				
Livestock farming experience (n = 395)						
Less than 16 years	221	55.9	17.26	12.47	3	38
16–30 years	104	26.3				
More than 30 years	70	17.8				
Membership in livestock associations (n = 442)						
Yes	40	9.0	0.09	0.28	0	1
No	402	91.0				
Regular contact with extension workers (n = 442)						
Yes	170	32.5	0.38	0.48	0	1
No	272	61.5				
The main purpose of raising livestock (n = 442)						
Commercial (Meat production)	198	44.8	n.a	n.a	1	5
Commercial (Milk production)	12	2.7				
Commercial (Meat and milk production)	66	14.9				
Personal use (meat or milk)	49	11.2				
Hobby	116	26.2				
Competition in beauty contests	1	0.2				
Animals (n = 442)						
Camels	93	21.1	n.a	n.a	1	4
Cows	29	6.6				
Sheep	363	82.2				
Goats	280	63.3				
Number of camels (n = 93)						
Less than 21	52	55.9	33.22	31.66	10	120
21–40	33	35.5				
More than 40	8	8.6				
Number of cows (n = 29)						
Less than 16	15	51.7	23.0	26.41	5	100
16–30	9	31.1				
More than 30	5	17.2				
Number of sheep (n = 363)						
Less than 101	122	33.6	144.66	92.3	70	850
101–200	110	30.3				
More than 200	131	36.1				
Number of goats (n = 280)						
Less than 51	123	43.9	96.48	82.29	50	550
51–100	81	28.9				
More than 100	76	27.2				
Type of livestock operation (n = 442)						
On pasture	263	59.5	n.a	n.a	1	4
Farm complex	60	13.6				
Barns	8	1.8				
Sheds	111	25.1				
Feeding system (n = 442)						
Green fodder and grazing	89	20.1	n.a	n.a	1	4
Green fodder and barely	143	32.4				
Compound feed	89	20.1				
Compound feed, barely, and green fodder	121	27.4				

As Table 1 shows, a clear majority of the respondents (82.2%) owned sheep, followed by goats (63.3%). In descending order, the average numbers of raising sheep, goats, camels, and cows were 144.66, 96.48, 33.22, and 23, respectively. Most breeders (59.5%) raised livestock on pasture, while around a quarter (25.1%) used sheds to raise their animals. Finally, 32.4% of the respondents depended upon traditional feeding (green fodder and barely) as a main feeding system in their farms, while 27.4% of them used compound feed, barely, and green fodder for feeding.

Attitudes of livestock breeders towards the use of compound feed

I realized through the clear results in Table (2) that the livestock breeders' responses regarding thick feed had a general arithmetic average of (3.03 from 5), which is the average stopping point in the third category of contribution on the five-point scale (from 2.61 to 3.40). This is the category that refers to Response for the "neutral" on the study tool in general.

The results show that there are new acceptances in the responses of livestock breeders about their attitudes towards compound feed, as the rubber standard deviation between 0.98 to 1.22, which indicates a comparison of the opinions of breeders about Mean, and this is confirmed by the overlap of the averages of agreement between 2.64 to 3.09, which are moderate, all falling into the third category of the five-point scale format, which indicates the score (neutral) on the study instrument, This demonstrates the homogeneity in livestock breeders' approval of compound feed.

The phrase "Compound feeds change the taste of livestock meat for the better" came in first place in terms of approval with a degree of (neutral) by the livestock breeders, with mean of 3.09 out of 5, and this is not consistent with what was mentioned by Alhidary *et al.* (2016) showed that the compound feed improved the carcass characteristics and meat quality of Naemi lambs. The phrase "Compound feed are higher in vitamins and minerals than natural feed (grains and Roughages)" came in second place in terms of approval with a degree of (neutral) by the livestock breeders with mean of 3.04 out of 5, and in third place came the phrase "Compound feeds improve the health condition of animals" In terms of approval with a degree of (neutral) with mean of 3.02 out of 5, this result is consistent with what was stated by Alhidary *et al.* (2017) showed that feeding lambs on compound diets may increase the incidence of rumen acidity, which affects the health and productivity of ruminants, It is not consistent with what was reported by Blanco *et al.* (2015) found that compound feeds did not cause health problems to animals when used to fatten young lambs in the UK.

On the other hand, the phrase "Compound feed increased the mortality rate" ranked eleventh in terms of approval with a degree of (neutral) with mean of 2.87 out of 5, followed by the phrase "Compound feed increased the pregnancy rate." It ranked twelfth in terms of approval with a degree of (neutral) with mean of 2.84 out of 5. Finally, the phrase "compound feed do not meet the nutritional needs of the animal" ranked thirteenth and last in terms of approval with a degree (neutral) with mean of 2.64 out of 5.

Table 2. Distribution of livestock breeders according to their attitudes towards compound feed.

Phrase	Strongly Agree%	Agree%	neutral %	not agree%	Strongly Disagree%	Mean	Std. dev.	Max.
Compound feed change the taste of livestock meat for the better	15.4	20.6	33.9	17.6	12.4	3.09	1.22	1
Compound feed are higher in vitamins and minerals than conventional feed (grains and Roughages)	8.4	23.3	42.3	15.6	10.4	3.04	1.07	2
Compound feed improve the health condition of livestock	6.3	27.1	40.5	14.5	11.5	3.02	1.06	3
Compound feed increases milk production for livestock	8.8	24.4	38.0	17.4	11.3	3.02	1.11	4
Compound feed available in the markets are safe	5.9	24.7	45.2	13.3	10.9	3.01	1.03	5
Compound feed are higher in energy than conventional feed (grains and Roughages)	11.5	15.2	43.2	22.9	7.2	3.01	1.06	6
Compound feed change the taste of livestock milk for the better	12.2	17.6	40.7	17.9	11.5	3.01	1.14	7
Compound feed is suitable for feeding livestock	7.9	27.4	34.8	16.5	13.3	3.00	1.14	8
Compound feed reduced the birth rate	4.8	20.4	49.3	15.4	10.2	2.94	0.98	9
Compound feed are higher in proteins than conventional feed (Roughages)	10.6	14.7	40.3	26.7	7.7	2.94	1.07	10
Compound feed increased mortality	6.1	17.4	45.5	19.5	11.5	2.87	1.03	11
Compound feed increased pregnancy rates	6.1	17.9	43.9	18.1	14	2.84	1.07	12
Compound feed do not meet the nutritional needs of the animal	6.3	10.6	38.5	29.9	14.7	2.64	1.06	13
General Mean					3.03			
General Std. dev.					0.74			

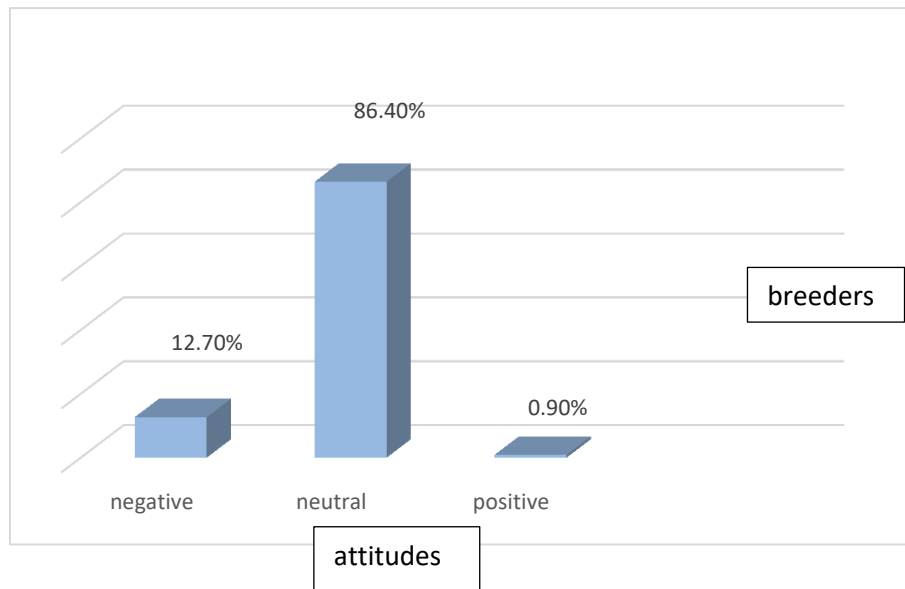


Figure1. Overall attitudes of livestock breeders towards compound feed.

Figure (1) shows the overall trends of livestock breeders towards compound feed. It is clear that the vast majority of livestock breeders, 86.4%, had neutral attitudes toward compound feed. The results indicate that breeders still need to create awareness of the importance of compound feed to help create positive attitudes that will be an incentive to increase the adoption rate of compound feeds. This is not consistent with the findings of Rasyid *et al.* (2018) who explained that although livestock breeders in Indonesia have still low knowledge of compound feed, they have a high interest in learning more about compound feed.

The relationship between some variables for livestock breeders and their attitudes towards compound feed:

The relationship of personal and social variables of livestock breeders to their attitudes toward using compound feed:

To determine whether there are statistically significant differences in livestock breeders' attitudes toward compound feed according to personal and social variables, the "Chi-square test" was used, and the results were as shown in Table (3) as follows:

The data presented in Table (3) indicate that the type variable (sex) has a significant relationship with breeders' attitudes towards using compound feed. The chi-square value was 9.09, which is a significant value at the level of (0.01). The differences were in favor of the male group. It was found that 70.7% of male had positive attitudes compared to 29.3% of female. This discrepancy may be due to male' experience in raising livestock compared to female, in terms of their follow-up on raising livestock and purchasing feed, and perhaps relying on it as a primary source of income, and the female' work in raising livestock is limited to feeding and manufacturing dairy products and their derivatives.

The data in the same table also indicate that the variable number of years of experience in raising livestock has a significant relationship with breeders' attitudes toward using compound feed. The chi-square value was 11.37, which is a significant value at the level of (0.05). The differences were in favor of the category of years of experience (less than 13 years), as it was found that 63.9% of breeders who had positive attitudes had years of experience of less than 13 years, compared to 33.3% and 2.8% of breeders who had years of experience. (13– 30 years) and (more than 30 years) respectively. This discrepancy may be due to the fact that breeders with fewer years of experience have modern trends in breeding methods and the use of modern techniques in nutrition, including compound feed, and they have a greater interest and motivation in adopting modern ideas. The data in the same table also indicate that there is no significant relationship between breeders' attitudes toward using compound feed and the rest of the personal variables studied.

Table 3: The relationship of some personal and social variables of livestock breeders to their attitudes toward using compound feed.

Variables	High		medium		Low		Chi-square	Significant level
	%	number	%	number	%	number		
Sex								
female	29.3	12	45.5	147	29.3	22	** 9.09	0.01
male	70.7	29	54.5	177	70.7	53		
Total	100	41	100	324	100	75		
Number of years of experience in raising livestock								
less than 13 years	63.9	23	46.9	136	31.9	22	* 11.37	0.02
years old 13-30	33.3	12	43.8	127	53.6	37		
More than 30 years	2.8	1	9.3	27	14.5	10		
Total	100	36	100	290	100	69		

** Function at a significance level (0.01), * Function at a significance level (0.05)

The relationship of the adopted feeding system to livestock breeders’ attitudes toward using compound feed

To determine whether there are statistically significant differences in livestock breeders’ attitudes toward compound feed according to the variable feeding system used, a chi-square test was used. The data presented in Table (4) indicate that the variable of the feeding system used has a significant relationship with breeders’ attitudes towards using compound feed. The chi-square value was 26.59, which is a significant value at the level of (0.01). The differences were in favor of the traditional feeding system (barley and roughages only); It was found that the percentage of breeders with low attitudes to the traditional feeding system amounted to 46.1%, compared to 25.0%, 21.1%, and 7.9% with compound feed systems + roughages, grazing+ purchasing roughages, and compound feed only, respectively.

This low trend towards the use of compound feed in feeding livestock may be due to several reasons, including the prevailing belief among the majority of livestock breeders that grains such as barley and roughages are natural feed and that compound feed are unnatural as a result of the culture and education of the breeder, and Compound feed may be weak in their resistance to weather factors compared to some types of grains such as barley, corn, etc., and consumer culture tends to distrust the meat of animals fed on compound feed.

Table 4: The relationship of the adopted feeding system to livestock breeders’ attitudes toward using compound feed.

Variables	High		medium		Low		Chi-square	Significant level
	%	number	%	number	%	number		
feeding system								
Grazing and roughages	9.8	4	21.2	69	21.1	16	**26.59	0.01
traditional feed (barley and roughages) only	12.2	5	31.7	103	46.1	35		
Compound feed only	36.6	15	20.9	68	7.9	6		
Compound feed + roughages	41.5	17	26.2	85	25	19		
Total	100	41	100	325	100	76		

** Function at a significance level (0.01)

The relationship of the number of years of using compound feed to livestock breeders’ attitudes toward using compound feed

To determine whether there are statistically significant differences in livestock breeders’ attitudes toward compound feed according to the variable number of years of using compound feed, a chi-square test was used. The data in Table (5) indicate that there is no significant relationship at the level of (0.05) between the number of years in which the use of compound feed began and breeders’ attitudes towards using compound feed. This result reflects that the timing of using compound feed was not a contributing factor in changing the outlook of livestock breeders towards compound feed.

Table 5: The relationship of the number of years in which compound feed began to be used and breeders' attitudes towards their use.

Variables	High		medium		Low		Chi-square	Significant level
	%	number	%	number	%	number		
Number of years of using compound feed								
1-2 years	15.6	5	36.6	56	40	10	10.64	0.1
3-7 years	34.4	11	32	49	20	5		
> 7yrs	50	16	31.4	48	40	10		
Total	100	32	100	153	100	25		

Conclusion

The results showed that 58.9% of the total livestock keepers were male, their age was less than 37 years (48.9%), their educational levels were secondary (34.4%), and their experience in raising livestock was less than 12 years (41. %). Livestock raising was the main occupation for most breeders (83%). Most sheep are owned by breeders (82.2%), and (59.5%) of livestock are raised in the desert. The main purpose of breeding was commercial (38%). Also, (52.5%) of livestock breeders do not use compound feed to feed livestock, and (16.7%) do not use compound feed to feed livestock. There is a percentage (65.7%) of breeders who want to continue using it. The vast majority of breeders, 86.4%, have neutral attitudes towards compound feeds. Therefore, it is important to educate breeders about the importance of feeding with diets that meet the nutritional needs of the animal according to its age and production status, and to intensify efforts and programs to increase the knowledge and skills of breeders to encourage them to apply modern practices in animal production through sound methods of feeding and care to make the livestock industry a more sustainable professional profession. And the development of applications and programs by the relevant regulatory authorities to help breeders verify the quality and safety of compound feed.

Author Contributions: Conceptualization, M.H.M and K.H. Z.; methodology, H. S. Q; software M.H.M formal analysis, M.H.M; investigation, M.H.M; resources, writing—original draft preparation, M.H.M; writing—review and editing, M.H.M; supervision, K.H. Z. and H. S. Q; project administration. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement: All data sets collected and analyzed during the current study are available from the corresponding author on fair request.

Conflicts of Interest: The authors declare no conflict of interest.

References

- Alexandratos, N., Bruinsma, J., 2012. World agriculture towards 2030/2050: the 2012 revision. www.fao.org/3/a-ap106e.pdf.
- Alhidary, I. A.; Abdelrahman, M. M.; Aljumaah, R. S.; Alyemni, A. H.; Ayadi, M. A.; and Al-Saiady, M. Y. (2017). Rumen Discoloration of Growing Lambs Fed with Diets Containing Different Levels of Neutral Detergent Fibre. *Pakistan Journal of Zoology (PJZ)*, 49(5): 1847-1855.
- Alhidary, I., Abdelrahman, M.M., Alyemni, A.H., Khan, R.U., Al-Mubarak, A.H. and Albaadani, H.H., 2016. Characteristics of rumen in Naemi lamb: Morphological characteristics in response to altered feeding regimen. *Acta. Histochem journal.*, 118: 331-337.
- Blanco, C., Giráldez, F. J., Prieto, N., Benavides, A, J., Wattedgedera, S., Morán, L., Andrés, b. S and Bodas, R. 2015. Total mixed ration pellets for light fattening lambs: effects on animal health. *Animal*, 9:2, pp 258–266.
- Codex Alimentarius. 2004. Code of practice on good animal feeding. CAC/RCP 54-2004.
- Council of Ministers. (2015). Stop growing green fodder. Resolution No. 66 dated 8 December 2015, Council of Ministers, Saudi Arabia.
- Food and Agriculture Organization of the United Nations (FAO). 2016. Livestock Contribution to Food Security in the Near East and North Africa. Food and Agriculture Organization of the United Nations Regional Conference for the Near East (2016) (April) 13.
- Linde, H.V.D., Oglethorpe, J., Sandwith, T., Snelson, D., Tessema, Y., Tiega, A. and Price, T., 2002. Beyond Boundaries: Transboundary Natural Resource Management in Sub-saharan Africa. pp.xxi + 166 pp.
- Makkar HP, Tran G, Heuzé V, Giger-Reverdin S, Lessire M, Lebas F, Ankers P. 2016. Seaweeds for livestock diets: A review. *Animal Feed Science and Technology*. 1; 212:1-7.

- 10) Ministry of Environment, Water and Agriculture, 2021. Total numbers of animals according to health card, unpublished data, Ministry of Environment, Water and Agriculture, Riyadh, Saudi Arabia.
- 11) Ministry of Environment, Water and Agriculture, 2020. Professional Guide for Livestock Breeders - Livestock Nutrition, National Plan to Improve Livestock Sector Productivity, Ministry of Environment, Water and Agriculture, Riyadh, Saudi Arabia.
- 12) Ministry of Environment, Water and Agriculture. (2019). Lifting government support for barley. Resolution No. (1441/1/291035) dated December 21, 2019, Ministry of Environment, Water and Agriculture, Riyadh, Saudi Arabia.
- 13) Rasyid, T. G., Amrullah, T., Kasim, S. N., Saleh, I. M and Rohani, S. (2018). Technology Adoption of Complete Feed by Cattle Cow Breeder. American Eurasian Journal of Sustainable Agriculture, 12(1): 1-4. <http://dx.doi.org/10.22587/aejsa.2018.12.1.1>.
- 14) Robinson TP, Thornton PK, Francesconi GN, Kruska RL, Chiozza F, Notenbaert AM, Cecchi G, Herrero MT, Epprecht M, Fritz S, You L. 2011. Global livestock production systems. Food and Agriculture Organization of the United Nations FAO.
- 15) Saudi Food and Drug Authority, 2017. Sheep Complete Feed, SFDA.FD 15/2017. ICS: 67.040.00, Saudi Food and Drug Authority, Riyadh, Saudi Arabia.