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Feeding and management of heat stress in livestock: Knowledge, perceptions and attitude of livestock keepers in District Okara, Punjab, Pakistan

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ABSTRACT

The objective of this study was to evaluate the knowledge, perceptions and attitude (KAP) of livestock owners and keepers towards feeding and management of heat stress in animals. A total of 72 livestock owners and keepers were interviewed through open ended survey questionnaire in district Okara, Punjab, Pakistan. Snow ball sampling technique was adopted to select livestock owners and keepers. All of the participants in the study think the animals can suffer heat stress. Majority of the respondents identify heat stressed animal from rapid breathing. Majority of respondents have poor knowledge regarding emergency relief to heat stressed animal; they believe drinking water should never be offered promptly (85.7 % males and 50.0 % females). Regarding giving bath to a heat stressed animal; majority of respondents in all categories do not agree. Majority respondents believe green fodder should be fed during hot hours whereas concentrate mix ration (CFM) should be fed during cooler hours of a day in summer. Majority of the respondents are unaware of the fact that animals should be given 24 hours fresh water availability rather they offer up to 3-4 times a day. The status of respondents KAP on feeding and management of heat stress in livestock is poor. Respondents were unaware of the importance of prompt cooling of heat stressed animals through fresh drinking water and bathing instead they offer local remedies that are harmful to overall health and welfare of animals. Majority of the respondents perceive green fodder as cool whereas CFM as hot source of energy.

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INTRODUCTION

Pakistan lies between 23 degrees 35 minutes to 37 degrees 05 minutes North latitude and 60 degrees 50 minutes to 77 degrees 50 minutes east longitude. It touches the Hindukush Mountains in the north and extends from the Pamirs to the Arabian Sea (UN-GIS, 2025). Climatically the plains of Pakistan, mainly constituted of Punjab and Sindh are dry and hot during summer months. The average temperature in these regions during summer months (April to September) exceeds 45°C (Pakistan studies-aips, n.d.). This high temperature is well beyond the thermal comfort zone of livestock making them victim of heat stress. So, during summer months heat stress is a major issue to livestock housed in plains of Punjab. High temperatures combined with high humidity significantly impact the health, productivity and reproduction of dairy animals especially high-yielding breeds such as Holstein Friesians and crossbred cows. Heat stress leads to economic losses due to reduced milk production and fertility issues.

Heat stress affects the dairy animals by hampering milk production, low quality semen, fertility issues in female animals, immune status and altered metabolism resulting in overall low production than the actual genetic potential of the breeds (Akbar et al., 2021). Previous studies revealing heat stress impacts on production of dairy animals showed a reduction in feed intake (Allen et al., 2015; Thorton et al., 2022) and subsequent decrease in milk volume. Nutritional management of livestock especially the dairy purpose animals is of most importance during summer months in order to reduce the negative impacts of heat stress (Akbar et al., 2021). The knowledge of livestock owners and keepers towards early detection and management of heat stress especially from nutritional view point is of pivotal importance in order to save the animals from negative impacts of heat stress and in turn avoiding economic losses.

The farmer level feeding and management includes selection of type of feedstuff, feeding time intervention of forages and concentrates and availability of fresh drinking water. Limit-feeding strategies, which involve controlling the amount of feed provided, have been shown to reduce heat stress in cattle. In a study, steers on a restricted-energy (RE) diet maintained their feed and energy intake better under hot conditions compared to those on high-energy (HE) and high-fiber (HF) diets. Additionally, steers on RE and HF diets consumed more water, aiding in thermoregulation (Crawford et al., 2022). Some of the farmers practice feeding of specialized supplements including amino acids, essential fatty acids, probiotics, antioxidant vitamins, trace minerals, and phytoactive compounds, can enhance metabolic, immune, and antioxidant responses during heat stress. These supplements improve animal health, welfare and productivity during critical periods like heat stress and post-parturition (Kotsampasi et al., 2024). If animals are not properly managed during heat stress it could lead to devastating impacts on health and production of

animals leading to big economic losses and subsequent failure of efficient milk and meat producing operations. Therefore, the current study investigates the knowledge attitude and practices of livestock owners and keepers in Tehsil Renala Khurd and Depalpur, District Okara towards nutritional management in case heat stress affects their livestock species.

MATERIAL and METHOD

The current study was conducted in Tehsil Renala and Tehsil Depalpur of District Okara, Punjab Pakistan. Okara is located 30° 48' 30.6000'' N and 73° 27' 33.8256'' E on the map of Pakistan at an altitude of 152.4 meters from sea level (Anonymous., 2004). The climate of city is warm and dry except the monsoon. During the hot months the temperature varies from 24 to 40 degree Celsius (Anonymous., 2024).

Data Collection

The data were collected (May 2024 to August 2024) from seventy-two (72) livestock owners and managers both male (28) and females (44) in varying age groups from young age to elderly and literacy level ranged from illiterate to graduation and above. The data were collected through survey using a structured pretested open-ended questionnaire on their management practices towards heat stress. The respondents were selected randomly from Tehsil Renala and Depalpur of District Okara and interviewed personally after informed consent.

Statistical Analysis

Collected data were analyzed using SPSS version 25.0 for frequencies and % age analysis. The degree of association among parameters was estimated using Chi-square test at a significance level of $p \leq 0.05$.

RESULTS and DISCUSSION

Current survey was conducted in Tehsil Depalpur and Renala khurd District Okara, Punjab, Pakistan to record knowledge attitude and practices of livestock owners and keepers towards feeding and management of heat stress in animals. Tehsil Depalpur and Renala Khurd are thickly populated with livestock.

Demographic Characteristics of Respondents

In this study total respondents were 72 of which 28 (38.9 %) were males and 44 (61.1 %) were females who were engaged in livestock keeping including cattle, buffalo, sheep, goat, horses, mules and donkeys. The majority of respondents (87.5 %) were above 20 years and below 50 years of age. in current study 26.4 % of the respondents were illiterate whereas 23.6 % attended school not more than fifth class (primary level). The majority of respondents (41.6 %) were those who were either under matriculation or matriculates. Only 2.8 % of these respondents were graduate. More females

participated in the study and it may be on account of the reason that females are more related to managing livestock as compared to males.

The Animals Could Suffer Heat Stress As Humans Can Do

Data is presented in Table 1 and shows that 100 % of the respondents among male and female, all age and education categories agree that animals do suffer from heat stress. The chi-square value for this could not be computed because response variable is constant.

Table 1. Do animals suffer heat stress?

	n	%	Yes %	No %	Do not know %	χ^2	*p*-Value
Gender							
Male	28	38.9	100.0	0.0	0.0	None	a
Female	44	61.1	100.0	0.0	0.0		
Age(years)							
up to 19	3	4.2	100.0	0.0	0.0	None	a
20-30	15	20.8	100.0	0.0	0.0		
31-39	15	20.8	100.0	0.0	0.0		
40-50	33	45.8	100.0	0.0	0.0		
51-60	5	6.9	100.0	0.0	0.0		
above 60	1	1.4	100.0	0.0	0.0		
Education							
Illiterate	19	26.4	100.0	0.0	0.0	None	a
Up to 5th	17	23.6	100.0	0.0	0.0		
6th to 9th	15	20.8	100.0	0.0	0.0		
Matriculate	15	20.8	100.0	0.0	0.0		
Intermediate	4	5.6	100.0	0.0	0.0		
Graduation & above	2	2.8	100.0	0.0	0.0		

a = no statistics could be computed as the parameter under investigation was constant

Rapid Breathing With Effort: Core Sign of Heat Stress in Livestock

Data for gender (χ^2=8.60: p = 0.035), age (χ^2=20.23: p = 0.163) and education (χ^2=14.39: p = 0.496) presented in Table 2 shows gender is positively correlated whereas age and education levels are not corelated with identification of heat stress from rapid breathing. The majority of respondents (78.6 and 93.2 % of male and female respectively) identify heat stress from rapid breathing with effort. Only a minor proportion (3.6 and 6.8 % male and female respectively) identify heat stress from behavior of animal being off feed and depressed. Another minor proportion among males (14.3 %) consider hyper salivation and frothing from mouth as core sign of heat stress. The similar pattern was observed among different age group where majority of respondents in all age groups believe rapid and effortful breathing as core sign of heat stress with minor proportions in other response groups like being off feed and depression. Among different education groups, the data shows that majority of

respondents identify heat stressed animal from rapid and effortful breathing (73.3 to 100.0%) irrespective of level of education. The finding of current study is endorsed by Silanikove et al. (2000), Ahmad and Tariq (2010) and Idris et al. (2021) who described increased respiratory rate as the easiest and one of the most adoptive methods of assessing heat stress in livestock. In contradiction to this high rate of respiration with effort, researchers in previous studies rate invasive methods as more appropriate ones for the identification and calibration of heat stress including assessment of rectal temperature, serological estimation of cortisol, estimation of metabolites in feces, urine and milk and infrared skin heat estimation respectively (Idres et al., 2021). High respiratory rate with effort is one of the behavioral expressions of heat stress in animals that is actually an adaptive response by animal body to lose heat increment on account of heat stress but sometimes animal suffering ruminal acidosis behaves the same way with panting confusing it with heat stress and this panting occurs to get rid of metabolic alkalosis for which compensatory metabolic acidosis develops confusing the same state (Re- Gele et al., 2023).

Table 2. How do you identify an animal suffering from heat stress?

	n	%	[a]Rapid breath %	[b]Off feed & depress %	[c]Salivation & frothing %	Do not know %	χ^2	*p*-Value
Gender								
Male	28	38.9	78.6	3.6	14.3	3.6	8.60	0.035
Female	44	61.1	93.2	6.8	0.0	0.0		
Age(years)								
Up to 19	3	4.2	100.0	0.0	0.0	0.0	20.23	0.163
20-30	15	20.8	80.0	6.7	0.0	13.3		
31-39	15	20.8	100.0	0.0	0.0	0.0		
40-50	33	45.8	87.9	6.1	0.0	6.1		
51-60	5	6.9	60.0	20.0	20.0	0.0		
above 60	1	1.4	100.0	0.0	0.0	0.0		
Education								
Illiterate	19	26.4	89.5	10.5	0.0	0.0	14.39	0.496
Up to 5th	17	23.6	94.1	5.9	0.0	0.0		
6th to 9th	15	20.8	73.3	6.7	0.0	20.0		
Matriculate	15	20.8	86.7	0.0	6.7	6.7		
Intermediate	4	5.6	100.0	0.0	0.0	0.0		
Graduation & above	2	2.8	100.0	0.0	0.0	0.0		

a = Rapid breathing with effort b= The animal is off feed and depressed c= hypersalivation with frothing mouth.

Mixture of Jaggery And Starch Is A Better Emergency Relief to A Heat Stressed Animal

The KAP data of livestock keepers is presented in Table 3 for gender (χ^2=26.18: p = 0.002), age (χ^2=50.74: p = 0.258) and education (χ^2=77.43: p = 0.002) show the gender and education levels are positively correlated whereas age is not correlated with the response variable. The majority of respondents 85.7 and 50.0 % of male and female respectively do not recommend prompt cooling and offering drinking water as an authentic relief to an animal suffering heat stress.

Table 3. How do you give emergency relief to an animal suffering from heat stress?

	n	%	Cool %	W.F %	G.F %	Jagg. %	J.F %	O.Y %	Butr %	Carom %	Glxd %	Don't %	χ^2	*p*-Value
Gender														
Male	28	38.9	14.3	3.6	3.6	32.1	10.7	7.1	3.6	3.6	7.1	14.3	26.18	0.002
Female	44	61.1	50.0	22.7	2.3	11.4	9.1	2.3	2.3	0.0	0.0	0.0		
Age(years)														
Up to 19	3	4.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.74	0.258
20-30	15	20.8	20.0	6.7	0.0	26.7	20.0	6.7	13.3	6.7	0.0	0.0		
31-39	15	20.8	26.7	26.7	0.0	33.3	0.0	0.0	0.0	0.0	6.7	6.7		
40-50	33	45.8	45.5	15.2	6.1	12.1	9.1	6.1	0.0	0.0	0.0	6.1		
51-60	5	6.9	20.0	20.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0	20.0		
above 60	1	1.4	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0		
Education														
Illiterate	19	26.4	42.1	5.3	10.5	21.1	5.3	5.3	5.3	0.0	5.3	0.0	77.43	0.002
up to 5th	17	23.6	41.2	35.2	0.0	5.9	11.8	5.9	0.0	0.0	0.0	0.0		
6th to 9th	15	20.8	20.0	20.0	0.0	33.3	0.0	6.7	0.0	0.0	0.0	20.0		
Matriculate	15	20.8	33.3	6.7	0.0	26.7	13.3	0.0	6.7	0.0	6.7	6.7		
Intermediate	4	5.6	50.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0		
Graduation & above	2	2.8	50.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0		

Cool = cool down the animal including watering, W.F = wheat flour suspension in water, G.F = gram flour suspension, Jagg. = jaggery solution in water, J.F = jaggery & flour suspension in water, O.Y = oil & yogurt suspension, Carom = carom seeds paste in water, Glxd = Galaxose-d in water

In age groups; young respondents (up to 19 years of age n=3) 100.0 % believe cooling as core emergency relief to heat stressed animals whereas respondents among all other age groups apply quackery and ill practices to deal with heat stressed animal including use of wheat flour suspension in water, jaggery solution in water, mixture of jaggery and flour suspension, vegetable oil with yogurt, milk butter, Galaxose-D solution in water and carom seeds paste in water. In education level groups; majority of respondents vote ill practices (50.0 to 80.0 %) as listed in Table 3, to deal with heat stressed animal. On contrary to the knowledge of livestock keepers in current study, previous research shows that feeding of starches and soluble sugars result into rapid fall of rumen pH leading to development of rumen acidosis that negatively hampers the health and production performance of ruminants (Stock 2000; Neubuaer et al.,2020). Whereas, in monogastric animals feeding of soluble sugars are not related with development of stomach acidosis as in ruminants but high starch feeding may be

related with development of other metabolic conditions like laminitis (Hoffman 2009; Eades 2017). The right practice to lower down the high body temperature in animals suffering from hyperthermia is cooling them with application of water in the form of bathing. Janczarek et al. (2022) concluded in a study on leisure riding horses that bathing of horses after physical activity of leisure riding is a useful strategy to reduces rectal temperature. Therefore, prompt cooling by water bath is an efficient way to cool down the animal by dissipating the heat content of animal suffering from heat stress.

Giving Water Bath to A Heat Stressed Animal Is Life Threatening

The KAP data on livestock keepers' opinion giving water bath to heat stressed animals by is presented in Table 4 for gender (χ^2=6.22: p = 0.045), age (χ^2=18.27: p = 0.051) and education (χ^2 = 20.23: p = 0.027) show the gender and education are positively correlated whereas age is moderately correlated with the response variable. Majority of the respondents (85.7 and 65.9 % of males and females respectively) do not recommend giving prompt water bath to heat stressed animals.

Table 4. Do you recommend to give water bath as an emergency relief to an animal suffering from heat stress?

	n	%	Yes %	No %	Do not know %	χ^2	*p*-Value
Gender							
Male	28	38.9	10.7	85.7	3.6	6.22	0.045
Female	44	61.1	34.1	65.9	0.0		
Age(years)							
Up to 19	3	4.2	66.7	33.3	0.0	18.27	0.051
20-30	15	20.8	20.0	80.0	0.0		
31-39	15	20.8	26.7	73.3	0.0		
40-50	33	45.8	21.2	78.8	0		
51-60	5	6.9	40.0	40.0	20.0		
above 60	1	1.4	0.0	100.0	0.0		
Education							
Illiterate	19	26.4	10.5	89.5	0.0	20.23	0.027
Up to 5th	17	23.6	41.2	58.8	0.0		
6th to 9th	15	20.8	0.0	100.0	0.0		
Matriculate	15	20.8	33.3	60.0	6.7		
Intermediate	4	5.6	75.0	25.0	0.0		
Graduation & above	2	2.8	50.0	50.0	0.0		

The gender distribution of respondents against responses shows that 10.7 and 85.7 % in males and 34.1 and 65.9 % in females respectively recommends and do not recommend giving prompt water bath to heat stressed animal. Among age groups; majority of respondents do not prefer giving prompt water bath to heat stressed animal (33.3 to 100.0 %). Respondents among level of education groups the majority do not agree giving prompt water bath to heat stressed animal (25.0 to 100.0 %). Majority of the respondents in current study believe that giving water bath to an

animal suffering from heat stress could be harmful to the health of animal to an extent that it could kill the animal on account of sudden cooling effect that can lead to failure of internal organs as heat is diverted to those organs especially heart and liver. This is a strong misperception that prevails among the livestock owners and keepers in the locality. On contrary to the findings of the current study, animals when free to choose, prefer to spent most of their time near water sources especially near shower and water troughs as the temperature humidity index closes towards heat stress (Ahmad and Tariq 2010; Legrand et al., 2011). Janczarek et al. (2022) concluded in a study on leisure riding horses that bathing of horses after physical activity of leisure riding is a useful strategy to reduces rectal temperature. Therefore, the right practice to lower down the high body temperature in animals suffering from hyperthermia is cooling them with application of water in the form of bathing.

Feeding Preferences For Livestock Suffering Heat Stress

The KAP data of livestock keepers is presented in Table 5 for gender (χ^2=16.96: p = 0.030), age (χ^2=63.95: p = 0.009) and education (χ^2= 38.02: p = 0.560) show the gender and age are positively correlated whereas education is not correlated with the response variable. Majority of the respondents (53.6 and 36.4 %) of males and females respectively recommend green fodder as a suitable feed stuff to feed heat stressed animals. Whereas, other response distribution includes application of quackery mixtures as represented in Table 5.

Table 5. What do you recommend to feed an animal suffering from heat stress?

	n	%	GFodd %	GF&WB %	WF sus. %	GF sus. %	Gx-d, GF, WB %	JF sus. %	GC-P %	Veg. oil %	Don't %	χ^2	*p*-Value
Gender													
Male	28	38.9	53.6	3.6	0.0	0.0	3.6	21.4	3.6	3.6	10.7	16.96	0.030
Female	44	61.1	36.4	6.8	11.4	13.6	13.6	15.9	0.0	2.3	0.0		
Age(years)													
Up to 19	3	4.2	0.0	0.0	66.7	0.0	0.0	33.3	0.0	0.0	0.0	63.95	0.009
20-30	15	20.8	80.0	0.0	6.7	0.0	0.0	6.7	0.0	6.7	0.0		
31-39	15	20.8	40.0	6.7	0.0	6.7	26.7	6.7	0.0	6.7	0.0		
40-50	33	45.8	33.30	3.00	6.10	12.10	9.10	24.20	3.00	3.00	6.10		
51-60	5	6.9	40.0	20.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0		
above 60	1	1.4	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Education													
Illiterate	19	26.4	26.3	5.3	15.8	21.1	0.0	10.5	5.3	10.5	5.3	38.02	0.560
Up to 5th	17	23.6	41.2	5.9	0.0	5.9	11.8	35.3	0.0	0.0	0.0		
6th to 9th	15	20.8	53.3	6.7	6.7	0.0	20.0	6.7	0.0	0.0	6.7		
Matriculate	15	20.8	46.7	6.7	6.7	0.0	6.7	26.7	0.0	0.0	6.7		
Intermediate	4	5.6	75.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0		
Graduation & above	2	2.8	50.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0		

GFodd = green fodder only, GF&WB = green fodder and wet wheat bran, WF sus. = wheat flour water suspension, GF sus. = gram flour water suspension, Gxd,GF,WB = galaxose-D, green fodder & wheat

bran, JF sus. = jaggery & flour suspension, GC-P = green coriander pastes in water, Veg. oil = vegetable oil has cool effect, Don't = do not know

Among age groups; up to 19 years of age; 66.7 and 33.3 % of the respondents recommend wheat flour suspension in water and jaggery and flour suspension in water respectively as a core feedstuff to heat stressed animal. Whereas, among all other age groups the majority vote green fodder (33.3 to 80.0 %) as most suitable feeding stuff for heat stressed animal and the rest of the options included quackery mixtures including wheat flour suspension in water, jaggery & flour suspension, green coriander paste in water and vegetable oil as core feedstuffs for heat stressed animals. Similar pattern was observed among respondents in different level of education groups with highest voting for green fodder (26.3 to 75.0 %). The other options taken by respondents were adoption of quackery mixtures as discussed in Table 5. Findings of current study show that majority of livestock owners and keepers believe water content in greed fodder makes it a cool source of energy to feed generally in summer and specifically to an animal when suffering from heat stress. They perceive it as an antidote ameliorating negative effects of heat stress.

On contrary to their perceptions the previous research has shown that roughages are feedstuffs that contribute to methane production more than concentrates especially crude protein rich mixes (Kurihara et al., 1997). Methane is instead a combustible gas containing heat energy from gross energy of the feedstuff (Blaxter and Clapperton 1965) that can further aggravate condition of heat stress. Second majority of the respondents believe mixture of jaggery with flour (wheat, barley or grams) in the form of suspension is a right choice for livestock including ruminants. Starches and soluble sugars are potential source of causing rumen acidosis that can be lethal when an animal is already suffering heat stress (Stock 2000; Neubuaer et al., 2020). The right choice for feeding a heat stressed animal is energy dense rumen lactate producer bacteria resistant feedstuffs like propylene glycol of which the respondents were found to be unaware (Hamzaoui et al.,2020; Akbar et al., 2021). The situation regarding knowledge of feeding stuff for an animal suffering heat stress is poor.

Livestock Keepers Perceive Prompt Access to Drinking Water Aggravates Heat Stress

Majority of the respondents 46.0 & 75.0 and 46.0 & 22.7 % of males and females respectively recommend 3 times and 3 to 4 times access to fresh drinking water to their animals during hot summer days. Among age groups; only minority of the respondents (up to 6.7 %) believe in frequent access to fresh drinking water. The majority allow limited access to fresh drinking water (up to 3-4 times a day). Similar pattern was observed in level of education groups; only up to 6.7 % of respondents believe in prompt and frequent access to fresh drinking water, whereas majority (above 90.0%) allow limited access. Majority of the farmers believe giving an access to fresh drinking water up to 3 times a day during hot summer is sufficient to animals.

This is another strong misperception on part of the farmers that need to be addressed. Tsai et al., (2020) demonstrated that frequency and length of bought of drinking the water was significantly increased with increase in climatic temperature.

Table 6. How many times do you offer drinking water to your animal during hot summer days?

	n	%	3 times %	3-4 times %	5-6 times %	χ^2	*p*-Value
Gender							
Male	28	38.9	46.0	46.0	7.0	6.17	0.046
Female	44	61.1	75.0	22.7	2.3		
Age(years)							
Up to 19	3	4.2	66.7	33.3	0.0	8.69	0.562
20-30	15	20.8	40.0	53.3	6.7		
31-39	15	20.8	66.7	26.7	6.7		
40-50	33	45.8	75.8	21.2	3.0		
51-60	5	6.9	40.0	60.0	0.0		
above 60	1	1.4	100.0	0.0	0.0		
Education							
Illiterate	19	26.4	78.9	21.1	0.0	31.40	0.001
Up to 5th	17	23.6	82.4	17.6	0.0		
6th to 9th	15	20.8	73.3	20.0	6.7		
Matriculate	15	20.8	33.3	60.0	6.7		
Intermediate	4	5.6	0.0	100.0	0.0		
Graduation & above	2	2.8	50.0	0.0	50.0		

Furthermore, previous studies indicate that the water requirements of livestock increase with increase in climatic temperature (Ittner et al., 1951; Arias and Mader 2011 and Ahlberg et al., 2018). According to Collier et al. (1982) reported an increase of water intake by 29% when climatic temperature increases from 20^0C to 30^0C. It has been established through previous research work that hydration improves plasma volumes leading to sweat and urine out puts and related cooling effect (Hodgson et al., 1994; Verdegaal 2022). Therefore, limited access to fresh drinking water is a mal management practice among livestock owners and keepers.

Livestock Keepers Advocate Feeding of Green Fodder During Hot Hours of A Day

The KAP data of livestock keepers on time of offering green fodder to livestock (ruminants) during hot summer days is presented in Table 7 for gender (χ^2 =0.13: p = 0.722), age (χ^2 = 1.40: p = 0.924) and education (χ^2 = 1.64: p = 0.896) show the gender, age and education are not correlated with the response variable. Majority of the respondents 57.1 & 61.4 and 42.9 & 38.6 % of males and females respectively recommend morning & evening and night hours as suitable time to feed green fodder.

Among age groups (from up to 19 years of age to above 60 years) majority (54.5 to 100.0 %) recommend succulent green fodder as most suitable feeding stuff during hot hours of a day in summer.,

Table 7. What is suitable time to feed green fodder to your animals during hot summer days?

	n	%	Day hours %	During night hours %	Do not know %	χ^2	*p*-Value
Gender							
Male	28	38.9	57.1	42.9	0.0	0.13	0.722
Female	44	61.1	61.4	38.6	0.0		
Age(years)							
Up to 19	3	4.2	66.7	33.3	0.0	1.40	0.924
20-30	15	20.8	60.0	40.0	0.0		
31-39	15	20.8	66.7	33.3	0.0		
40-50	33	45.8	54.5	45.5	0.0		
51-60	5	6.9	60.0	40.0	0.0		
above 60	1	1.4	100.0	0.0	0.0		
Education							
Illiterate	19	26.4	68.4	31.6	0.0	1.64	0.896
Up to 5th	17	23.6	52.9	47.1	0.0		
6th to 9th	15	20.8	60.0	40.0	0.0		
Matriculate	15	20.8	53.3	46.7	0.0		
Intermediate	4	5.6	75.0	25.0	0.0		
Graduation & above	2	2.8	50.0	50.0	0.0		

Whereas, respondents count was less than 45.5 % in all age groups who proposed night hours as suitable time for green fodder. The pattern was similarly followed by the respondents in level of education groups; majority (50.0 to 75.0 %) agreed to feed green fodder during day hours as compared to night hours (25.0 to 47.1 %). Majority of the farmers in current study perceive green fodder as cool source of energy for its higher water content therefore they advocate its consumption during hot hours of a day during summer. The findings of current study are contradicted by Sekine et al. (1986), Shibata et al. (1992) and Jhonson & Jhonson (1995) who reported an increase in methane production with feeding of roughages and decrease in methane production with feeding of concentrates high in crude protein content. Instead of cooling effect feeding of green fodder may prone the animal more to be affected of heat stress for its methanogenic activity. Methane is a combustible gas that contains heat energy a major part of gross energy of feedstuff that microbes in the rumen produce after exploitation of substrates (Blaxter and Clapperton 1965). Therefore, this is a strong misperception of farmers that needs to be addressed for animal welfare.

Livestock Keepers Conceive Concentrate Feed Mix As A Hot Energy Source

The KAP data of livestock keepers on time of feeding concentrate feed mix to livestock (ruminants) during hot summer days is presented in Table 8 for gender ($\chi^2 = 18.55$: p = 0.001), age ($\chi^2 = 16.40$: p = 0.691) and education ($\chi^2 = 29.76$: p = 0.0.074) show the gender is positively correlated, age is not corelated and education is only moderately correlated with the response variable.

Table 8. What is suitable time to feed Concentrate feed mix (CFM) to your animals during hot summer days?

	n	%	Milking time %	Night hours %	Only morning %	Only evening %	Should not be given %	χ^2	*p*-Value
Gender									
Male	28	38.9	7.1	14.3	17.9	50.0	10.7	18.55	0.001
Female	44	61.1	4.5	4.5	0.0	90.9	0.0		
Age(years)									
Up to 19	3	4.2	0.0	0.0	0.0	100.0	0.0	16.40	0.691
20-30	15	20.8	6.7	20.0	0.0	60.0	13.3		
31-39	15	20.8	13.3	6.7	13.3	66.7	0.0		
40-50	33	45.8	3.0	3.0	6.1	84.8	3.0		
51-60	5	6.9	0.0	20.0	20.0	60.0	0.0		
above 60	1	1.4	0.0	0.0	0.0	100.0			
Education									
Illiterate	19	26.4	0.0	0.0	10.5	89.5	0.0	29.76	0.074
Up to 5th	17	23.6	5.9	0.0	0.0	94.1	0.0		
6th to 9th	15	20.8	0.0	13.3	6.7	73.3	6.7		
Matriculate	15	20.8	20.0	13.3	13.3	47.7	6.7		
Intermediate	4	5.6	0.0	25.0	0.0	50.0	25		
Graduation & above	2	2.8	0.0	50.0	0.0	50.0	0.0		

Majority of respondents in gender group 50.0 & 90.9 % of males and females respectively recommend evening as suitable time to feed CFM perceiving it a hot energy source for livestock (ruminants). Among males 7.1, 14.3, 17.9 % and in females 4.5 and 4.5 % respectively recommend milking time, night hours and only morning as the suitable time for feeding CFM. Whereas 10.7 % of the males do not recommend feeding of CFM during summer season. Among age groups; 60.0 to 100.0 % of the respondents believe cooler hours of the day is the most suitable time to feed CFM. Among level of education groups; similar pattern as in above groups was followed with 47.7 to 94.1 % of the respondent believe cooler hours of day as the most suitable time to feed CFM. Majority of livestock keepers perceive concentrate feed mixes that are usually rich in protein content as hot source of energy and therefore oppose its use in hot summer days especially to those animals that suffer heat stress. Previous studies showed that protein rich concentrates are less methanogenic as compared to low protein concentrates or otherwise rich in carbohydrates (Jentsch et al., 2007). Furthermore, among carbohydrates sources roughages are more methanogenic as compared to concentrates whether starch based or protein based (Blaxter and Clapperton 1965). The high protein diets and low in fiber reduce methane production in ruminants (Chagas et al., 2021; Santander et al., 2023; Oh et al., 2024). Therefore, it can be concluded from previous studies that energy and protein concentrate mixes are less methanogenic as compared to green fodder and it is better to feed concentrate feed mixes than green fodder during hot hours in summer.

CONCLUSION AND RECOMMENDATIONS

The current study reveals the level of KAP (knowledge, attitude and practices) of local livestock farmers on heat stress providing comprehensive knowledge on feeding and management of livestock in hot climate regions like Pakistan. The findings of current study indicate a need to run awareness raising campaigns and training programs of livestock farmers towards better management of heat stress in livestock addressing the prevalent misconceptions in this regard. Animal welfare and productivity can be enhanced by provision of fresh drinking water round the clock, rescheduling the feeding routines and adoption of effective cooling methods. The sample of study is limited to single region; it would be better if similar studies may be conducted in more geographical areas. Further studies should be conducted to evaluate the impact of interventions in the form of farmer trainings and awareness campaigns on KAP and experimentally assess the effectiveness of strategies aimed at increasing awareness on heat stress.

Conflict of Interest

The authors have declared that there are no competing interests.

Authors Contribution

RYA and IR conceptualized the study idea, IR and NU managed the project. RYA along with MS and IR managed data collection. RYA, AA and SA managed the collected data for statistical analysis. RYA, EUK and MA completed the editing of manuscript.

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