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Ethno-veterinary Practices of Heat stress Management for Small Ruminants in Sindh

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ABSTRACT

The indigenous knowledge has traditionally been used to control the health of livestock with natural resources through ethno-veterinary practices (EVP). EVP is an important factor in reducing the heat stress in small ruminants, which is directly related to the productivity of livestock and the livelihood of farmers in heat-prone areas like Sindh as well as Pakistan. The paper seeks to report and discuss EVP measures used by farmers, veterinarians and animal health practitioners in heat stress control of sheep and goats in Sindh. This was done using a multistage stratified sampling method in seven districts. Structured questionnaires were used to gather data on 180 farmers and 30 animal health practitioners in 2021 and 2022. There were also socio-demographic variables, including age, education, experience in farming. Most of the respondents (97.6%) had known about heat stress and implemented different EVP measures. Some of the key practices were provision of water (98%), adoption of strategy of water provision placed 1st in small ruminant, shade (95%), 3rd in sheep, 2nd in goat, air-ventilation (81%) 4th in sheep, 3rd in goat, feed adjustments and supplement (76%) 5th and 4th, bedding (47%) 6th and 5th , and selection of breeds that are tolerant to heat (38%), at 7th and 6th ranked in sheep and goat respectively. There were also reported 96% of sheep had wool shaved at rank 2 and 2.4% of goats had hair cut at rank 7 in order to minimize heat loss. The systems of farming were mainly semi-intensive (72%), then intensive (21%), and extensive nomadic (7%). There were evident variations between farmers and practitioners in the EVP application due to the difference in knowledge bases and experiences. EVP offers affordable, readily available and culturally sensitive measures of controlling heat stress

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in small ruminants. Combining the traditional veterinary and the aboriginal ways would improve the sustainability and resilience of livestock in heat stricken areas of Sindh.

Key words: Ethno-Veterinary, Heat Stress Management, Small Ruminants, Live-Stock Management, Sindh Pakistan, Indigenous Knowledge.

INTRODUCTION

Indigenous knowledge of ethno veterinary practices (EVP), regimental and use for curing different natural ailments of animals and birds has existed since time 10-15 thousand BC (Aziz et al., 2018; Zeineldin et al., 2018) The ethno veterinary system is based on folklore, beliefs, knowledge, wisdom, experience, and the skill of management different strategies and utilizing natural medicine, such as minerals, animal sources, and plant species, acquired by the local livestock holders and herdsmen (Abidin et al., 2021; Shoaib et al., 2021) Rural dwellers depend on livestock specially small ruminants for livelihood, economic security, and food and therefore it is an utmost necessity to take help of cheap, easily accessed, safe local and natural resources which are tested for long time on the animals (Sulfiar et al., 2020). It is effectively used for primary health care treatment of animals for health and productivity, which provides an alternative to expensive drugs available in the market. It is also reported that though the classical system of treating ailment is familiar to all over the country, these systems are known to few individuals (Shoaib et al., 2020).

High temperatures exert a serious environmental constraint in future to the performance, well-being and health of small ruminants in hot and arid agro ecological zones such as Sindh province in Pakistan (Sahoo & Sharma, 2023). In the summer season, small ruminants are at risk of heat stress, which can negatively impact their health and productivity (Abd-Allah & Zanouny, 2014; De, 2022; Sawyer & Jitik Narayan, 2019) Farmers protect their animals from this heat by using various strategies, natural resources and traditional remedies (De, 2022; Devi et al., 2026). Heat stress management strategies comprises of fresh water for drinking and bath (Li et al., 2018), shed of trees for prevent direct sun exposure and radiation (Khant et al., 2021), air and ventilation (Koluman & Daskiran, 2011a), feed and feeding frequencies The use of different natural remedies known as ethno veterinary medicine, include the use of medicinal plants such as chicory seeds, mint leaves, nigella sativa, polygonum bistort root which provide cooling (Devi et al., 2026; Eldeeb et al., 2026; Mizsser, 1981) hydration, liver supports, digestive, and immune boosting for the animals (Mizsser, 1981; Zeineldin et al., 2018), shearing in sheep (Khant et al., 2021) and selection of heat tolerating breeds (PR, 2017). Sindh is a historically and geographically diverse region at the crossroads of various bio geographical zones and ancient civilizations. The geography of the region covers arid deserts, wetlands and coastal areas with climatic conditions varying between hot Thar Desert to the temperate areas of the north. Therefore present study is proposed for the adoption of different strategy of heat stress management in small ruminants by EVH in Sindh for mitigates environment heat stress.

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MATERIALS AND METHODS

Study area

The research took place in the Sindh Pakistan, seven districts including Tando Muhammad Khan, Hyderabad, Tando Allahyar, Mirpur Khas, Matiari, Shaheed Benazir Abad and Jacobabad. Study areas are presented in figure 1. High temperatures are associated with these areas, which makes them appropriate in the case of analyzing the heat stress management method in small ruminants. Sindh is an important agricultural area in the southern east of Pakistan and stands at a latitude 23.5° - 30 N and a longitude of 68° - 77 E, covering a total of about 140,914 km2 with about 5 million small ruminants, primarily sheep and goats (2023 estimate). The province has a tropical desert climate which means that there is a lot of heat, low amount of rainfall, and clear seasonal change where the average temperatures vary between 25 - 35 °C, and in summer; the temperature may go up to 50 °C (April-July). The wide geography of Sindh and its closeness to the Arabian Sea have an impact on the climate of the region, as it is highly suitable to the livestock farming, particularly in rural communities.

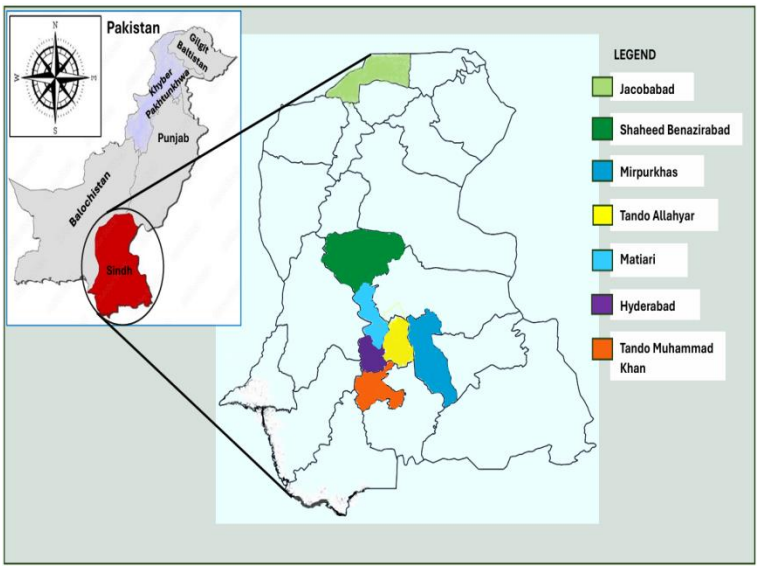


Figure 1: Map of study area different districts of Sindh.

Methodology

Sampling Strategy a multistage sampling technique was used, to have a representative sample of the sheep and goat farmers in the seven districts of Sindh, in urban, rural, and semi-rural setting (Garba et al., 2015). The sample was divided into 180 livestock farmers and 30 practitioners and veterinarians, and the number of participants per district was equal. Face to face interviews by using the structured questionnaire were used in data collection (Jamal et al., 2022). Farmers were requested to fill in the details regarding their understanding of heat stress, a common symptom of heat stress within their animals, and the exact steps that are implemented to prevent heat-related problems. To record pertinent information, the fieldwork was run March-May 2021-

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2022 month.

Statistical Analysis

The data analyses were used in the descriptive and inferential statistical procedures to determine the prevalence and nature of heat stress management practices. The relationship between the heat stress management practice and such variables as district, herd size, and farmer experience were analyzed utilizing excel file and Chi-square SPSS software. Percentage of the adopted strategy was calculated by following equation:

$$\textbf{Percentage}\ (\%) = \left(\frac{\textbf{NORAS}}{\textbf{TR}}\right) \times \mathbf{100}$$

Where,

NORAS is represents number of respondents adopting strategy and **TR** is a total respondent.

Results

In the current study the respondents were classified into the categories as shown in Fig 2, according to their main functions in the livestock management. Most of the respondents were farmers, presenting the traditional livestock farming 86% as dominant and scattered in the region. Respondents 14% were practitioners, who most likely included local experts and paraprofessionals in animal health. These minor classifications denote the variety of functions in livestock management with different roles towards farming, and animal health farming.

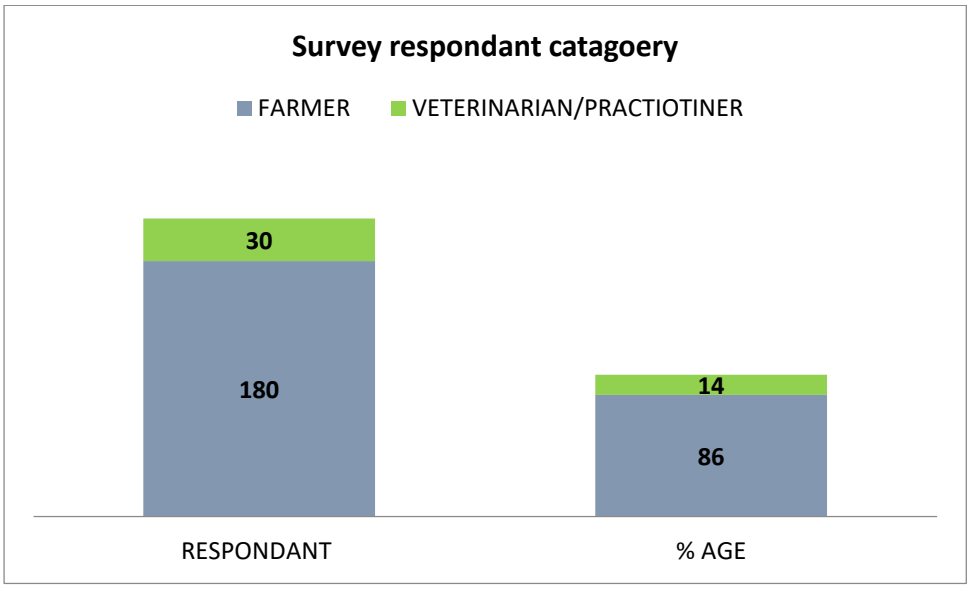


Figure 2: Respondent category in the survey of adoption different strategies in heat stress management by EVH of Sind in small ruminants.

The study examined age, experience and the education of farmers and practitioners engaged in agricultural practices. The results, as shown in table 1, demonstrate that there is a significant disparity in demographics, experience, and education among the respondents.

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Table1: Survey respondent ethno veterinary healers (EVH) age, experience and education.

Category	Variable	Minimum	Maximum	Mean	Std. Deviation
Farmers	Age	18	65	36.92	10
	Experience	5	40	15.88	7
	Education	Illiterate	Graduate	3.58	0.93
Practitioner	Age	24	55	34	6.5
	Experience	3	32	6.23	6.5
	Education	Illiterate	Graduate	3.78	0.41

The age of the farmers (18-65 years) had a mean of 36.92 with a standard deviation of 10 and was considered to have a wide range of ages as well as education and experience levels ranging between 0-18 years (mean 3.58). Practitioners were aged 24-55 years (mean 9.5) with experience of 3-32 years (mean 6.23), which is between farmers, veterinarians or practitioner in terms of experience, and education of 10-12 years (mean 3.78), which falls between farmers and veterinarians as well. The differences in the study were identified to be clear between farmers and practitioners involved in ethno-veterinary age, experience, education and practices, which cover a wide range of knowledge on traditional livestock healthcare. The agricultural practices in the study area were mixed livestock management systems as shows in Fig 3.

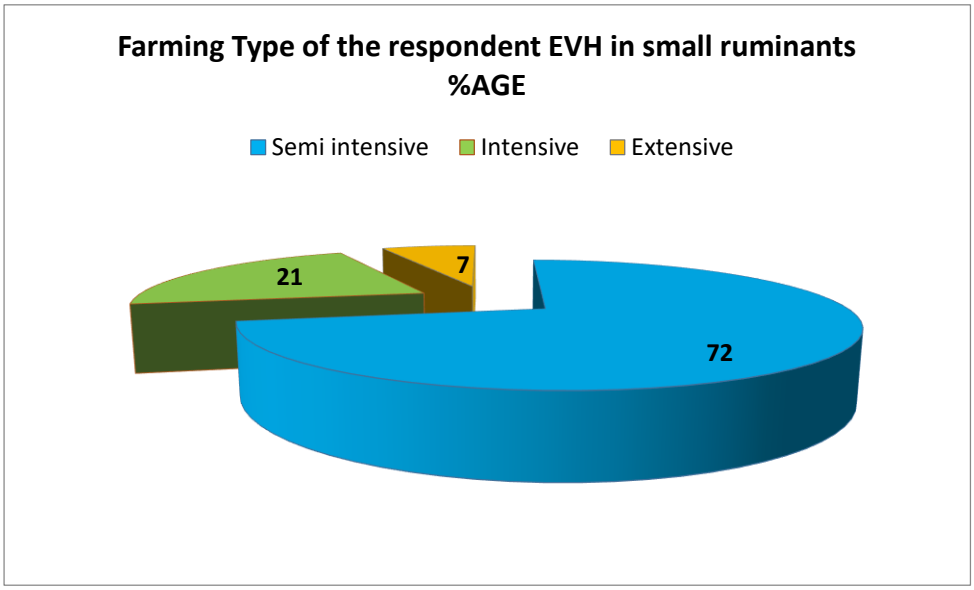


Fig 3: Farming type of the respondent ethno veterinary healers (EVH).

The questionnaire divided the respondents into various types of farming systems that they had. Semi-intensive was the most prevalent type of farming and 72 percent of the

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respondents said they were using the same system (Younas et al., 2018). It is a composite method mostly entailing a combination of grazing and feeding on a stall. The 21% of the respondents practiced intensive farming which depends on the production of animals and feeding on a limited scale. The lower percentage of 7 went through a widespread system of agriculture by nomads who have animals grazing freely with little human interference. This shows that semi-intensive area farming is the most active in these Sind districts indicating that there is a balance between the utilization of resources and animal care especially in the heat stress management. Ethno veterinary healers (EVH) are the type of farming of the respondent.

The questionnaire tested the knowledge of the respondents (Table 2) with regard to heat stress and its effects on small ruminant.

Table 2: Heat stress effects awareness of EVH on the small ruminant.

Awareness heat stress	Frequency	%Age
No	5	2.4
Yes	206	97.6

The findings revealed that the awareness of the respondents was high and 97.6 percent of the respondents stated that they were aware of heat stress and its possible impact on the health and productivity of animals. Only 2.4 percent of the respondents reported and further understood through follow up discussion that they were unaware of heat stress.

Ethno veterinary healers of Sindh have a variety of strategies to deal with heat stress in sheep and goat and give primary importance to those that concentrate on water, shade, air and ventilation, diet changes, bedding and heat tolerant breed adaptation and shearing specially in sheep.

Table 4: Different Heat stress management strategies in Sheep adopted by EVH.

Heat stress management Sheep	Respondent (n=210)	% Age	Ranked priority (1-7)
Shearing	202	96.19	2
Feed and Feeding	160	76.19	5
Shads	200	95.24	3
Bedding	99	47.14	6
Water	205	97.62	1
Air and Ventilation	170	80.95	4
Tolerant Breed	80	38.10	7

The ethno veterinary practitioners in Sindh use various approaches in dealing with heat stress in sheep, with the emphasis being made on water, shearing, shades, air and ventilation, diet manipulation, bedding and selection of heat tolerated breed. The most adopted strategy is the ranked 1, water which 97.62 percent of the respondents highlighted and they stressed on its use in cooling and hydration. Shearing of sheep is

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widely adopted procedure 96.19% with Ranked 2, which is used by EVH for manage and reduced heat stress impact. Shade is very popular as well (85%, Ranked-3), which gives sheep some relief against direct sunlight that helps to reduce the impact of heat stress. The most commonly used, by 91.94%, ranked-4 of those interviewed, is air and ventilation, which will keep the environment cool, perhaps by enhancing air circulation in the enclosed areas. Feeding modifications, which are practiced by 93.36% of the respondents, strategy adopted ranked-5, include provision of moist and cooling feeds, alternating high energy diet, antioxidant, appetizing natural element and the timing to prevent feeding during the best heat hours. Bedding of sand is reported strategy 47.14 % with ranked 6, while heat tolerant breed 38.10%, Ranked-7 adopted strategy by EVP in Sindh for the management of heat stress management of sheep.

Table 4: Different Heat stress management strategies in Goat adopted by EVH.

Heat stress management Goat	Respondent (n=210)	% Age	Ranked priority (1-7)
Trimming Hair	5	2.38	7
Feed and Feeding	160	76.19	4
Shads	200	95.24	2
Bedding	99	47.14	5
Water	205	97.62	1
Air/Ventilation	170	80.95	3
Tolerant Breed	80	38.10	6

Ethno veterinary healers of Sindh have adopted a range of measures to treat heat stress of goats, which are based on the water, shade, air and ventilation, feeding options, bedding, selection tolerant breeds and shearing or trimming of hair. The most widespread of these is the provision of water strategy with ranked 1, as 97.62% of the respondents took water to make goats cool and keep them hydrated. The use of shade (95.24% Ranked-2) is also widespread as natural source tree and it serves to cover goats with sunlight, which will lower heat stress. The respondents of 80.95%, Ranked-3 are air and ventilation to enhance air flow that helps in cooling goats, particularly in confined spaces. The adjusting of feeding and using natural feed additives supplementation and used is also universal with 93.36% Ranked-4 of the respondents having done this, perhaps due to high density, moisture, cooler, refrigerant and natural appetizer feeds supplements or feeding at a cooler time of the day. Strategy management of bedding Rank-5, 47.14% reported. Another tactic of using heat-tolerant goat breeds is employed by 38.10%, Ranked-6 of respondents meaning that they are aware that breeds vary in heat tolerance and understand that as a heat resistant strategy to avoid heat stress.
Finally shearing or trimming of hair is reported only 2.38%, Ranked-7 in goat as strategy mitigate heat stress. There are certain differences evident in species-specific approaches. Shearing (96% of the respondents) are also very important in delivering thermal load reduction on sheep by eliminating wool which is an insulator. This is not applicable to goats whose hair does not insulate as much. Rather, goats can depend, more on

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behavioral and feeding adaptations since they can forage in shaded or cooler places due to their agility and their ability to selectively feed. These plans show adaptive approach to heat stress management, and this is due to physiological and behavioral variations between the two species. The most commonly used ones are water and shade because of their immediate and practical effect of relieving the heat stress. Adjustments ventilation and feeding are also important, the level of heat management in the environment and inside. The only animal that shearing is effective in sheep weather goats have a natural advantage of having their heat and choosy feeding habits. Breed selection, which is less popular, enhances the long-term sustainability as it helps facilitate traits that are heat resilient. These measures combined will show a holistic and flexible attitude to the health and viability of sheep and goats in the arid climate of Sindh.

Discussion

Ethno-veterinary practice (EVP) is a long-standing system of traditional knowledge, management protocols, and utilization of natural resources with the intention of preventing illnesses and reducing production and welfare penalties in small ruminants in heat stress (Badar et al., 2017). The current results suggest that the decreases in feed consumption, productivity, and animal welfare due to the heat stress may be significantly avoided by a combination of EVP-based management practices. The socio-demographic background of ethno-veterinary healers (EVHs) indicates that this knowledge is not only practiced in the age demographic that is economically productive but also not limited in the age demographic of the elderly populations. The age, experience, and education levels of the farmers and practitioners are relatively evenly distributed, which implies a continuous experience-based learning process as well as a slow transition of knowledge between the generations. Notably, the similarity in the education between both groups nullifies the belief that ethno-veterinary knowledge is confined to illiterate populations (Kalyan et al., 2014). The co-existence of formal education and traditional knowledge instead forms an opportunity to make systematic documentation and make EVP more rational. Livestock keepers in the study location had an excellent level of awareness of heat stress (97.6%), which is indicative of a high level of practical awareness of the dangers of high ambient temperatures (Al-Dawood, 2017). This kind of awareness is probably fuelled by the recurrent losses related to the costs of productivity in the season of high temperatures and the extension activities, and it serves a decisive factor in the implementation of the relevant mitigation measures.

There were also no significant species-wise differences in the adoption of six core practices (water provision, shade, ventilation, feed management, bedding, and heat-tolerant breeds; $p > 0.10$), suggesting a generally uniform approach to the management of heat stress (Idris et al., 2014). But differences at the species level were also observed in shearing practices. The second strategy that had been embraced in sheep was shearing as it was evident that it helped in the dissipation of heat in a more efficient manner by means of conducting and evaporative routes. Conversely, its insignificant occurrence in goats indicates the applied knowledge of farmers in terms of thermoregulatory species-specificity since the majority of goats have shorter hair coats in which shearing has minimal or no value (Thonney et al., 2022).

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The most important strategy was the provision of drinking and bathing water (De et al., 2020), and no significant differences were found between the districts ($p > 0.05$). Sufficient water supply facilitates thermoregulation, evaporative cooling, and hydration and ultimately decreases heat-induced oxidative stress (Ghassemi Nejad & Sung, 2017; Munn et al., 2009, 2014). Bathing was effective, but it was only adopted in areas where water and labor were accessible, which agrees with experimental evidence on the cooling effects of water sprinkling (M. Zhang et al., 2021). Another strategy that was ranked highly was shade and the differences between this strategy and other practices were very high ($p < 0.05$) (Caroprese et al., 2012). Regular with experimental literature, shade decreases radiant heat load, rectal temperature, respiration rate, and signs of stress (Habeeb, 2020). The broad application of natural shade especially trees in all the districts underscores its applicability universality in large scale systems and the high degree of consistency between EVP perceptions and known thermo physiological principles (Marcone et al., 2021). EVHs widely publicized airflow and ventilation strategies as cost-effective and acceptable interventions (Koluman & Daskiran, 2011b). The design of open or semi-open housing is directed toward the prevailing winds and made of locally available materials, which improves the movement of air and minimizes the heat and humidity. Although these practices are backed by scientific evidence on the advantages of a greater amount of airflow, a quantitative assessment of these practices under controlled conditions is one of the essential gaps in research (X. Q. Zhang et al., 2016).

Herbal supplementation and nutritional management were not regarded as primary interventions reported by EVH. The farmers vary the type of feed and meal timing to the colder seasons recognizing the decrease in the amount of dry matter consumed (Singh et al., 2021), and the increase in the maintenance needs caused by heat stress (Hurley et al., 2021). This observation reflects nutritional observations that dietary options may aid in metabolic and antioxidant defense mechanisms but will not be able to overcome extreme heat burden of the environment (Karthik et al., 2021). There was a moderate but significant effect on bedding management. Dry or moist sand and soil on shady resting places is used to minimize conductive heat transfer of hot ground surfaces, and enhance the comfort of animals. Bedding is an aspect of heat stress experiments that has been little studied and although related to EVHs, it was found to be important in open and semi-confined systems and therefore, the heat load due to ground may be an under researched factor related to thermal stress in the field. Lastly, the breeds that are heat tolerant were considered to be a long term adaptation measure and not a solution to acute heat waves (McCann et al., 2016). Although there is strong scientific evidence on the role of genetic adaptation to heat (Autukaitė et al., 2020), the short-term irrelevance that is perceived by EVHs depicts the practical limitation in smallholder systems. In general, the paper illustrates that ethno-veterinary heat stress management practices are very much aligned with the scientific knowledge, as well as context-dependent and pragmatic, which highlights their applicability and adaptability to climate-resilient livestock management systems.

Overall, the implementation of these mitigation measures implies significantly a proactive response of the farmers in the area, which is probably informed by the traditional knowledge, as well as, through the extension services. Nevertheless, the

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differences in rates of adoption indicate that socio-economic aspects, availability of resources, and the ecological conditions on the local level could possibly affect the availability of various interventions. These results warrant the context-intensive extension programs and policy support to boost resilience against increasing climatic temperatures caused by climate change.

Conclusion

It is concluded that ethno-veterinary interventions are very crucial and efficient to reduce the losses in production and welfare of small ruminants due to heat stress in agro-climatic conditions prevailing in Sindh. The excellent awareness of heat stress among farmers and ethno-veterinary healers, and the extensive use of pragmatic measures to reduce heat stress, including water supply, shade, ventilation, shearing (in sheep), and supportive feeding control, is indicative of excellent experiential knowledge in accordance with animal thermoregulatory physiology. The results also indicate that ethno-veterinary is not confined to the elderly or illiterate population but it is in practice in the productive age groups with different levels of education. In general, EVP-based approaches are economical, locally flexible and acceptable within culture and thus especially applicable to smallholder and resource constrained livestock systems that are experiencing mounting challenges of heat stress.

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Conflict of Interest

Author and co-authors declared no conflict of interest and agreed for publication of present research data.

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