Research Article

Research System [IKRS] for Treatment of Bloat and its Significance towards Greenhouse Gas Emission: Jharkhand, India

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Abstract | National Innovation Foundation-India had redefined livestock innovation system in India through green grassroots technological innovations and outstanding traditional knowledge practices. The institution address the requirement for future generation to understand values of Indigenous Knowledge Research System through empirical evidence. Communities maintain these knowledge systems for their sustenance with help of learnings from nature. This research study is one such example to showcase medicinal value of novel veterinary medication preserved by outstanding traditional healer Shri. Sitanath Munda, Jharkhand state of India. The experience reiterates importance of building trust and reciprocity towards knowledge holders as advocated by Honey Bee Network. Social interaction with creative society and peer group pressure enabled healer to share a medication in treatment of bloat among ruminants. This medication AHP/JH/SM was tested against clinical condition in small ruminants. It was found that average abdominal girth of bloated goats [0^{th} hour, 81.33 ± 3.61 cms] was significantly reduced by 2.5 hours of post treatment [76.66 ± 4.86 cms]. It had significant impact by improving rumen motility from 0^{th} hour [0.50 ± 0.34] to 2.5^{th} hour [1.33 ± 0.21] as well as 8 hour [1.66 ± 0.21] of post treatment. An in-vitro rumen simulation experiment confirmed its property to sustain pH and restored viability of rumen microflora. This had resulted in 50 percent reduction of gas production thereby reduced emission of greenhouse gas. These effective formulations need to be incorporated in intervention program of animal husbandry departments. This will enhance the scope of interaction between formal resource personnel with society to understand, imbibe and to act on local wisdom. More evidences have to be generated to understand tacit value of Indigenous Knowledge Research System [IKRS] in addressing environmental concern.
crossmark.crossref.org/dialog/?doi=10.14737/journal.aavs/2016/4.5.241.249**&domain=pdf&date_stamp=2008-08-14**
Keywords | Bloat, Greenhouse Gas, Assessment, Validation, Indigenous, Ruminants

Editor | Kuldeep Dhama, Indian Veterinary Research Institute, Uttar Pradesh, India.
Received | May 10, 2016; **Accepted** | May 27, 2016; **Published** | May 28, 2016
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Citation | Munda S, Pandey R, Bhojne GR, Dakshinkar NP, Kinhekar AS, Kumar V, Ravikumar RK, Kumar V (2016). Indigenous Knowledge Research System [IKRS] for treatment of bloat and its significance towards greenhouse gas emission: Jharkhand, India. Adv. Anim. Vet. Sci. 4(5): 241-249.
DOI | http://dx.doi.org/10.14737/journal.aavs/2016/4.5.241.249
ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331

INTRODUCTION

Bloat, Concern for Animal Productivity and Welfare

Bloat is an important non-infectious systemic disorder affecting digestive system of ruminants. The ailment cause discomfort to animal due to distention of rumen causing management difficulty to veterinary service provider. The rate of occurrence of bloat conditions in the field was to the extent of 9 percent (Sarker et al., 2013). The nature of forage behaviour of animals over legume grass have considerable bloating potential (Maughan et al., 2014). Animals in most part of the world have to thrive on grazing hence alternative legume forages were tried to minimize incidence of bloat. Lack of provision of veterinary services remains an impediment under small ruminant livestock production system (Rao et al., 2013). Available medications and managerial role were expensive, difficult to administer, not able to control bloat every time and not necessarily opt with existing grazing regimen of livestock (Berg et al., 2000). These also pose challenge to farmers who rely on enhancing milk yield through pasture management (Bramley et al., 2013; Lean et al., 2008; Stafford and Gregory, 2008). It is necessary to meet global food security by fostering sustainable practices in respect to environmental concern (Scholtena et al., 2013). The nature of feeding system and changing preference in rearing of livestock by smallholders need to be given adequate consideration in promotion of location specific technologies (Ravikumar et al., 2015).

Scientific Assessment of Technologies in Treatment of Bloat

The severity of the condition were observed through visual assessment of distention of rumen, frothiness and codifying the data through scientific scale (Majak et al., 1995). The intra-ruminal pressure and rumen motility were considered as criteria during experimentation involving bloat trials (Colvin et al., 1959). The frequency of ruminal contraction had direct implications on digestion (Sunagawa et al., 2002). Volume of gas produced (Fay et al., 1980), time period in resumption of distended rumen and rumination process (Digraskar et al.,2012) were considered in assessment of technologies for rumen function. Rumen distension causes decrease in feedintake, a critical parameter to relieve animals from bloat (Villalba et al., 2009). Rumen protozoa had significant role not only in digestion but also production of enteric methane (Nguyen et al., 2016). The influence of agent on flora of rumen like protozoa, anaerobic bacterial species and on rumen gas production were found to be critical factors. The use of condensed tanins (CT) against gas production (Min et al., 2005) and saponins on protozoa for aiding digestion (Das et al., 2012) testify relevance of these parameters. The foaming of rumen ingesta is an important factor (Colvin et al., 1959) and cytoplasmic protein plays major role as foaming agent in causing bloat in cattle (Mangan, 1959). This is due to the fact of maintaining desired amount at rumen-reticulum in specified period for to overcome foaming (Reid, 1958). Supplementation of rain tree pod meal and different concentrate ration had decreased pH, protozoa and methanogens among dairy steers (Anantasook et al., 2013). Studies by Liu et al. (2016) refer that rumen pH of less than 6.2 have effect on microbial synthesis and cellulose digestion. The primary aim is to keep incidence of bloat at a threshold level by acting on pH and foam formation. However, there was limited literature indicating likely duration of time medical formulation need to act to control clinical signs of bloat.

System of Addressing Rumen Function and Bloat among Farm Animals

Use of penicillin and ionophores such as monensin, lasalocid for treatment and control of bloat was considered safe and advocated (Johns et al., 1959; Katz et al., 1986). Mineral mixture was also considered as an appropriate strategy to minimize occurrence of bloat (Hall et al., 1994). In general, treatment of bloat involves use of antibiotics and or plant based measures that contains CT (Lees, 1992). This is reiterated by the fact that since 2000 to present, role of CT in minimizing occurrence of bloat, methane gas production and on anaerobic bacteria was studied (Vasconcelos and Galyean, 2008). The positive role of CT on milk production and health status were attributed (Dey and De, 2014).

Causal relationship of farm grazing pattern and incidence of bloat were demonstrated (Carruthers and Henderson, 1994). Several studies were conducted to bypass rumen so as to make available nutritional requirement at lower gut to ensure enhanced growth performance (Odedra et al., 2016). Further, use of ionophores in cattle diets was part of strategy to curtail enteric methane emissions as well (Guan et al., 2006). Studies indicated that feeding of oak leaves can reduce methane production level and recommended safe inclusion levels in the diet of ruminants (Rajkumar et al., 2015). The general thought is to enhance the forage digestibility and digestible forage intake as key to mitigate methane production (Hristov et al., 2013). The growing public concern over animal welfare, pollution and health aspects of animal produce will have direct bearing on livestock production systems (Wilson and Lawernce, 1985). Knapp et al. (2014) suggested that performance enhancing technologies need to be considered in protecting environment.

Relevance of Indigenous Knowledge Research Systems

Need for sustaining Indigenous Knowledge Research Systems (IKRS): The rate of technological requirement necessitates development of skill to innovate and need suitable public support for such innovative human capital (McGuirka et al., 2015). Studies by Ravikumar et al. (2016) referred importance of Indigenous Knowledge Research System in sustaining welfare of livestock. This dynamic knowledge system has been forefront to complement efforts of formal research system like animal husbandry department for health care and productivity. Outstanding traditional knowledge holders had gained valuable insights of medicinal value and are keen to share information to needy farmers (Ravikumar and Kumar, 2015). These environmental friendly formulations need to be encouraged not only for sustenance but for animal welfare (Periyaveeturaman et al., 2015). The environmental challenges demand system-wide transformations in understanding and utilizing sociotechnical systems that were amenable (Seyfand and Haxeltine, 2012; Bruce, 2013). These technologies can help to minimize use of chemicals that cause unwarranted welfare issues in small holder dairy farming system (Ravikumar et al., 2015a). Further, utility of IKRS beyond the place of origin were demonstrated reinforcing belief for its relevance, wider diffusion potential (Ghorai et al., 2016).

Scaling up of innovations derived from Indigenous Knowledge Research Systems: Openness in innovation system provides suitable environment for knowledge diffusion through informal mechanisms (Ropera et al., 2013). Working closely with community and to seek their valuable contribution with new social order of knowledge helps to document novel veterinary medication (Kumar and Ravikumar, 2016). These grassroots innovations which can provide technologies for social inclusion has three challenges viz., responding to location specific need simultaneously seeking wide scale diffusion, being appropriate to prevailing needs and towards goal of social justice (Smith et al., 2014). Different models of incubation of IKRS like Non Linear Innovation System (NLIS) and Open Source Innovation System (OSIS) were discussed for wider utility of native wisdom (Ravikumar and Kumar, 2015). The attributes of dairy innovations have to be identified for effective diffusion and adoption among farming communities (Rathod and Chander, 2016). There needs to be shift from presenting these innovations as divider of national innovation wealth to a provider (Jain and Verloop, 2012). Further, sharing of knowledge system is vital for sustaining ability of future generations towards farm animal welfare (Ravikumar et al., 2016a). These knowledge has been confined to surviving older people and few practitioners causing concern of loss of sustainable wisdom (Usha et al., 2016). Gupta (2007) calls for inspiring younger generations so as to improvise knowledge thereby overcoming threat of erosion.

Framework for Livestock Innovations

IKRS can able to develop desirable technologies as creative individuals in similar situation can comprehend better and work out appropriate solutions. Scientific governance have to emphasis on responsible innovation to overcome societal difficulties (Stilgoea et al., 2013). Use of these knowledge and technologies brings out positive changes to improvise agricultural development (Ayele et al., 2012). However, in most circumstances custodian of knowledge were not at the forefront. Recognizing outstanding healers who sustained IKRS through their creative spirit and experimentation has been articulated by Honey Bee Network (HBN) (Gupta, 2006; Kumar and Ravikumar, 2016). HBN pioneered the concept of grassroots innovation and laid down basis of support system for future (Ustyuzhantseva, 2015). In-order to avail affordable solutions, society has to learn from green grassroots innovations and traditional knowledge holders (Gupta, 2012). The product derived for wealthy customer may not be fulfilling low income and emerging markets (Simula et al., 2015).

Gupta et al. (1997) argues that collaborative learning can be enjoyable and meaningful if only dialogues between farmers-scientists are matched with ethical parlance. Sharing of scientific results with healer and enabling interactive meeting with villagers resulted in sharing of empathetic livestock innovation (Devgania et al., 2015). These novel livestock medications had emerged with participation of outstanding knowledge holders and livestock owners by addressing livestock ailments (Ravikumar et al., 2016b). These arrangements provided meaningful engagements and partnership with informal institutions' (Kumar and Ravikumar, 2016a). Custodians of this knowledge through their observations had conserved utility value of herbal medications. This had emboldened usage, mode of dispensation, desired dosage against affected animals in their vicinity. Gupta (2007a) refer that communities living close to nature can understand and interpret values of local resources.

IKRS and Environmental Responsibility

World's half of livestock population are raised in tropics and there is imminent need to address methane production by them (Thao et al., 2014). The public concern in overcoming global warming potential of animal farming operations through feed have to be taken cared (Kaufmann, 2015). The major components of gas produced in rumen are CO_2 (45-70%) and CH_4 (20 to 30%) (Clarke and Rein, 1972). Strategies need to be considered to decrease greenhouse gas (GHG) emissions per kg of milk produced (Zehetmeier et al., 2012). The demand for sustainable livestock production compels research system to explore approaches to minimize greenhouse gases (GHG) (Wanapat et al., 2015). The use of trace elements like Zinc and copper for performance enhancement resulted in impairment of plant production, accumulation in animal products, water supply chain and antimicrobial resistance (Brugger and Windisch, 2015). Reducing methane emission by enhancing feed digestibility through rumen microbial ecosystem is pertinent (Anantasook et al., 2013). Evidences to initiate further experiments to understand role of indigenous system in reducing GHG were shared (Ravikumar et al., 2015c). Thornton (2010) indicate that livestock production systems have to operate in responding to environment constraints.

Thus the study was carried out to articulate the need for network meeting among creative individuals and to share nature of disclosure by traditional knowledge holder during peer group meeting. This disclosed medication from indigenous knowledge research system was clinically evaluated against bloat conditions based on comprehensive clinical parameters analysed as above. Further experimentation was conducted to determine its role in greenhouse gas emission through *in vitro* ruminal gas production.

MATERIALS AND METHODS

The study was conducted over a period of time with help of organizing network meeting among healers in the regions of Jharkhand, India 2013-2015. This involves partnership with creative individuals, building network of knowledge holders through personnel interview, field investigations. The documented practice during the workshop was tested against clinical condition of bloat and evaluated for its impact over greenhouse gas emission. The study was undertaken to share the development of medication based on knowledge of creative communities. This study brings an approach for scientific assessment of indigenous knowledge practice as well as to understand utility value of medication beyond the specific claim. This research also demonstrated useful parameters for evaluation of medication in treatment of bloat. A novel approach for documenting societal learning was shared in the value chain of IKRS.

Clinical Evaluation of Indigenous Veterinary Medication against Bloat Condition

Six healthy adult goats affected with natural bloat conditions were selected for efficacy evaluation. Their health parameters like pulse, temperature, respiratory rate, abdominal girth and rumen motility were observed. Girth of the abdomen in (centimetres) for each goat was recorded. The herbal medication AHP/JH/SM was administered orally as per healers' dosage. Post treatment girth was measured at the same level/spot of first measurement at 2.5 hours and 8 hours.

Evaluation of Impact through *in vitro* Rumen Simulation Model

Collection, preparation and maintenance of rumen contents: The goat ruminal contents were collected from slaughter house and carried to laboratory in air tight pouch. The ruminal contents were strained through muslin cloth with the help of artificial saliva. In order to maintain anaerobic condition, carbon dioxide was blown directly to the container containing strained rumen fluid. The water bath of in vitro rumen model was filled with ordinary water and heated to 38^0C before start of experiment. This temperature was maintained up-to 30 minutes to prevent any shock to rumen microflora due to temperature difference. Ruminal chambers were filled with strained ruminal fluid of about one litre and assembly were fitted as per manufacturer's instruction (Rumen *In vitro* model: RUSI-E-TEK, EAGA tools and instruments, Chennai). Subsequently, ruminal contents were kept in ruminal chambers for 2 hours at 38^0 C and in anaerobic condition in enabling adaptation of rumen microflora.

Preparation of artificial saliva: About two litres of artificial saliva was prepared by dissolving 19.6 g sodium bicarbonate, 9.94 g Disodium hydrogen arthophophate, 1.14 g potassium chloride, 9.4 g sodium chloride, 0.246 g magnesium chloride and 0.08 g calcium chloride in 2 litres of distilled water as per standard protocol. The pH of the artificial saliva was adjusted to 8.2.

***In-vitro* rumen fermentation:** The salivation tube, gas collection bags, overflow tubes were fitted and experiment was started. The saliva was regulated in cyclic manner such that after each 20 seconds the saliva was released for duration of 4 seconds. The test medication was enclosed in non-digestive semi permeable membrane pouch in ruminal chamber and assembly was marked as Test chamber. In order to evaluate the efficacy of test preparation, the pH parameter was noted in control chamber (without medication) and test chamber (with medication) for a period of 0, 1, 2, 3 and 4 hour's duration. The experimental protocol was carried out as per earlier studies (Ravikumar, et al., 2015b).

Quantification of viability of protozoa: The gas produced was quantified after 4 hours of experimentation. The viability of protozoa was quantified based on observing motility and density of protozoa. They were observed under 40X microscope as per standard method. The rating was based on motility of protozoa in rumen liquor, a score of +++ indicates normal digestive function and ++ suggest poor digestion of feed due to abnormal rumen fermentation. The total number of protozoa was counted with help of haemocytometer and results were expressed as total count per ml (n x 10^5). A score of 0, 1+, 2+, 3+ represents motility of protozoa in terms of nil & dead, slow & very few, moderate & less number and rapid & very large population movement of protozoa (Ravikumar et al., 2015c).

Quantification of total gas production: The gas collection bag was attached to water filled air tight bottle and outlet pipe was kept in measuring jar. The quantity of water collected in measuring cylinder was considered as a quantity of gas produced by artificial rumen in litre(s) unit.

Analysis of results: The results were compared and analysed statistically (Gupta, 2000).

RESULTS AND DISCUSSION

Role of Peer Group Pressure and need for Network Meeting among Creative Individuals

Earlier studies had shared importance of network meeting among creative individuals in different regions (Ravikumar et al., 2015d). These network meetings can able to build mutual respect and trust through understanding the nature of efforts in value chain. Pressure of expectation can be made rationale and demonstrated willingness of outstanding knowledge holders to be part of mainstream activities.

Table 1: Efficacy assessment against various health parameters

Health Parameters	0 Hour (Mean±S.E.)	2.5 Hour (Mean±S.E.)	8 Hour (Mean±S.E.)
Pulse rate / min	46.16 ± 8.55	41.83 ± 5.78	44.83 ± 4.10
Temperature in ^{0}F	101.55±0.25	101.41±0.29	101.15 ±0.33
Respiration rate /minute	25.00 ± 1.23	25.66 ± 0.61	24.83 ± 1.10
Abdominal girth (cm)	81.33 ± 3.61	76.66±4.86*	80.66 ± 3.84
Rumen motility /min	0.50 ± 0.34	1.33 ± 0.21*	1.66 ± 0.21*

* Mean differ significantly P<0.05

An interactive meeting with herbal healers in the regions of Dom Mandae, Raye block, Ranchi District, Jharkhand was conducted. Several healers had participated and shared their knowledge by showcasing medicinal plants brought by them or collected, presented before them. However, outstanding knowledge holder Shri Sitanath Munda did not share his valuable experience at first instance of interaction. Discussion with other healers was conducted along with other healers by observing plants, sharing of medicinal properties. Specific ingredients were informed towards treatment of injuries and such other conditions. Subsequently **Shri. Sitanath Munda** had narrated novel property of the medicinal plant in treatment of bloat among farm animals.

It illustrated the need for interactive intervention programs that can enrich better understanding of utility of plant based treatment under IKRS. This is in concurrence with Gupta (1997) who shared that participatory learning through peer group interaction offer alternatives or variations known to healers. Models of engaging community or stakeholders in disclosing such variations in novel medications were shared through interaction between healer and livestock farmers (Devgania et al., 2015). Technical, ethical and methodological challenges in IKRS have to be unearthed (McCorkle, 1995). These innovations shared to overcome difficulties of farmers have to be basis of livestock service delivery system. In the present study disclosure of knowledge through peer group participation model was demonstrated. This is an illustrative example for an innovation model wherein the peer-group pressure had ensured the knowledge holder to share his knowledge. The social influence had enabled to communicate this unique knowledge and in the process, social learning provided innovative solution. Montgomery and Caterline (1996) referred social influence and social learning as fundamental components for diffusion. These innovation models explain importance of conducting network meetings with stakeholders such as farmers, among knowledge holders to explore different facets of technical know-how of IKRS. The scope of farmer participation in local research with help of creative individuals can be built upon through establishment of common experimental objectives and relationship based on trust (Conroy, 2002).

Clinical Efficacy Indigenous Veterinary Medication AHP/JH/SM

The health parameters of affected goat in respect to pulse, temperature, respiration rate per minute, abdominal girth and rumen motility were recorded at 0, 2.5 and 8 hour intervals (Table 1). The study found that experimental animals had average pulse rate of 46.16 ± 8.55, 41.83 ± 5.78 and 44.83 ± 4.10 at 0, 2.5 and 8 hours respectively. Slight reduction in pulse rate was observed in bloated goats during post treatment period of 2.5 and 8 hours. However, this reduction difference was non- significant (Table 1).

The average temperature at before treatment (0^{th} hour) was 101.55 ± 0.25^{0}F which was slightly reduced down to 101.15 ± 0.33^{0}F at 8 hour post treatment. This reduction in body temperature was not significant (P<0.05). The average respiration of bloated goats was 25.00 ± 1.23 before treatment (0 hour) which was slightly reduced to 24.83 ± 1.10 on 8 hour post treatment. This variation in respiration rate was found to be non- significant (P<0.05).

The average abdominal girth of bloated goats at 0 hour (before treatment) was 81.33 ± 3.61 cms. After treatment with test medication it was reduced to 76.66 ± 4.86 cm at 2.5 hours and further to 80.66 ± 3.84 cm at 8 hours. Significant (P<0.05) impact of test medication AHP/JH/SM by 2.5 hours post treatment over abdominal girth parameter was noted. The increase in abdominal girth at 8 hour might be due improved appetite and ingestion of feed. This indicated that treatment with AHP/JH/SM was effective against bloat in goats.

The animals after treatment with medication AHP/JH/SM was observed with improved ruminal motility from 0 to 8 hour post treatment. Significant (P<0.05) impact over ruminal motility was noted at 2.5 hours as well as at 8 hours interval. This proved that medication AHP/JH/SM was effective at given doses and improved ruminal digestion.

Role of IKRS in Minimizing Greenhouse Gas Emissions

The clinical efficacy confirmation necessitated the need to understand role of indigenous medication in rumen

Table 2: Impact of medication under *In vitro* rumen fermentation model

SN	Medications	0 hrs	1 hrs	2 hrs	3 hrs	4hrs	Mean±SE
Effect of medication over pH							
1	Control (Negative)	5.9	5.9	5.7	5.6	5.6	5.74±0.06
2	Test Medication (AHP/JH/SM)	6.1	6.0	6.1	6.1	6.1	6.08±0.02
Impact on rumen microflora: Protozoan motility and density							
SN	Medications	Before (0 hrs) Start of experimentation			After (4 hrs) In-vitro rumen fermentation		
		Motility		Density	Motility		Density
1	Control (Negative)	3+		3+	3+		2+
2	Test Medication (AHP/JH/SM)	3+		3+	3+		3+
Total protozoan count							
SN	Medications	Before (0 hrs) Start of experimentation (n X 10^5)		After (4hrs) In-vitro rumen fermentation (n X 10^5)			Percent change (%)
1	Control (Negative)	11.50		9.00			21.73
2	Test Medication (AHP/JH/SM)	12.25		12.10			01.22
Quantification of gas production: *In vitro* gas production							
SN	Medications	Before (0 hrs) Start of experimentation (ml)				After (4hrs) Invitro rumen fermentation (ml)	
1	Control (Negative)	0				1200	
2	Test Medication (AHP/JH/SM)	0				600	

fermentation (Table 2). Rumen fermentation process is influenced by pH (Kang et al., 2016) and prolonged period of decreased pH in rumen environment have to be regulated for effective feed utilization (Brzozowska et al., 2013). The impact of medication over pH was recorded for a duration of 4 hours in rumen simulation model. It was found that in test chamber pH (6.08±0.02 (Mean±SE)) was found to be more than control chamber (5.74±0.06 (Mean±SE)) (Table 2). The pH of rumen content tend to decrease in control chamber due to utilization of carbohydrates. However, the test medication maintained the pH towards alkalinity in the test chamber. The calculated percent change of total protozoan count in control chamber was 21.73% while in test chamber it was only 1.22 per cent. Maintaining suitable pH i.e., buffering capacity might have protected viability of rumen microflora. This was reflected in observed protozoan motility and density pattern.

The quantification of gas was carried out and found less in test chamber. The calculated per cent different of gas production between control and test chamber was found to be 50 per cent. This decrease in gas production can minimize release of different components of greenhouse gas such as CO_2 and CH_4. This may be due to optimum digestive ability of rumen microflora due to impact of medication. This is in agreement with Hristove et al. (2013) who refer that enhancing forage digestibility as recommended efforts for methane mitigation. Thus activities need to be reinforced to understand merit of knowledge prevalent in informal society towards environmental concern.

CONCLUSION

The research study shared an illustrative model of peer group innovation/ peer group participation model through lateral learning workshops among creative individuals. There were limited studies shared worldwide to enrich creativity and understanding of grassroots livestock innovations. Clinical efficacy of novel medication in treatment of naturally bloated goats was significant as indicated by reduction in abdominal girth and improvement in rumen motility. The other parameters like temperature, pulse were within normal limits. The medication had maintained buffering capacity and sustained the ruminal microflora. This suggested that the novel medication had improved digestive capability and controlled bloat condition in ruminants. Further, the study also articulated role of such medications in minimizing environmental concerns by reducing ruminant gas production. Thus formal research and service delivery system need to join hands to complement welfare of overall livestock production system. The study also calls for revamping structural arrangement to utilize affordable excellence existing at farmer's doorstep. The study argues that efforts have to be reinforced widely so as to encourage healers to be part of mainstream service delivery system. Appropriate framework needs to be developed for comprehending usage of Indigenous Knowledge Research System as accessibility of technology will remain challenge for farmers.

ACKNOWLEDGEMENT

Prof Abdul Samad (Retd.), Director of Instruction and Dean Faculty of Animal and Veterinary Sciences, Maharashtra Animal and Fishery Sciences University (MAFSU), Nagpur, India for his support and guidance during clinical experimentation.

CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTION

All authors contributed equally to the manuscript.

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