

Original Research Article

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Disease Incidence and Mortality Pattern of Migratory Sheep Flocks in Marwar Region of Rajasthan, India

S.C. Kantwa*, T.K. Mohanty, T.K. Patbandha, S.S. Layek and A. Kumaresan

Livestock Production Management Section, ICAR - National Dairy Research Institute, Karnal- 132 001, Haryana, India

*Corresponding author

ABSTRACT

Sheep migration is a traditional solution to seasonal unavailability of feed and water resources. However, the difficulties faced by nomadic shepherds during en route migration have not been clearly understood. Hence, the present study was designed with the objective to identify disease incidence and mortality pattern along with constraints faced by shepherds during en route migration in Marwar region of Rajasthan. The information on disease incidences [enterotoxaemia, Foot and Mouth Disease (FMD), sheep pox and Peste des Petits Ruminants (PPR) and abortion] and mortality rate were collected from 20 migratory sheep flocks, comprised of 3208 sheep during en route migration from December 2011 to June 2012. Average flock strength of migratory shepherds was 160 with smallest flock of 70 to largest flock of 310 sheep. Incidence of enterotoxaemia, FMD, sheep pox and PPR was observed to be 16.68, 9.26, 11.13 and 13.90%, respectively. The overall abortion and mortality rate of sheep flocks were 9.66 and 10.60%, respectively. There was significantly ($p < 0.001$) higher incidence of diseases and mortality rate in young animals as compared to the adult animals. Major constraints perceived by the shepherds during en route migration were nutritional stress (95%), lack of availability of medicines (95%) and Veterinary facilities (90%), predators (65%), climatic stress (50%) and road accident (40%). Taken together, it may be concluded that enterotoxaemia incidence occurs mostly during en route migration and cause huge mortality. Further, nutritional stress together with lack of availability of medicines and Veterinary facilities aggravate the health problems. Thus, implementation of better nutritional and health management practices during en route migration could reduce the disease problems and mortality.

Keywords

Migration, Sheep, Disease incidence, Abortion, mortality.

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Introduction

India holds second position in sheep population (74.5 million *i.e.* 7.14% of world population) next to China in the world (BAHS, 2013). Sheep contribute significantly to the national economy and provides sustained income and livelihood to rural migratory shepherds on low input with moderate output system of sheep farming. Sheep has developed specific adaptation to

survive and produce under adverse local environmental conditions with low input production system. Sheep husbandry in Rajasthan, Himachal Pradesh, Jammu and Kashmir, Andhra Pradesh and Tamil Nadu is still based on nomadic pastoralism and is a traditional solution to seasonal non availability of feed and water resources in drought prone regions (Kala *et al.*, 2005;

Kumaravelu *et al.*, 2008; Rao *et al.*, 2011; Suresh *et al.*, 2011). Migratory sheep flocks follow some well-established routes for a definite period in a year depending on rainfall pattern, availability of feed and water resources. However, during migration shepherds confront high morbidity and mortality in flocks due to different diseases and causes significant economic loss (Kataria *et al.*, 2007; Suresh *et al.*, 2008). Knowledge about the health problems and the constraints faced by the shepherds during en route migration is needed to identify the future opportunities for policy reforms which would promote environmental friendly sustainable production and economic security to the nomadic pastoralism. Hence, the present study was designed to document disease incidence and mortality pattern along with the common problems faced during en route migration by shepherds of Marwar region of Rajasthan.

Materials and Methods

The present study was conducted on migratory sheep flocks during migration from Pali to Rohtak (December 2011- June 2012) to know the disease incidence (enterotoxaemia, FMD, sheep pox and PPR and abortion) and mortality pattern along with the common problems faced during en route migration. A total of 3208 sheep (2123 adult and 1085 young) from 20 flocks were followed during the study period. The sheep flocks were visited at 20-30 days interval during migration and the case histories were collected to confirm the disease based on the clinical signs and symptoms. Disease incidence and mortality rate were calculated as per the method described by Bhanuprakash *et al.*, (2005).

$$\text{Disease incidence rate (\%)} = \frac{\text{Number of new cases during migration}}{\text{Total number of sheep at risk during migration}} \times 100$$

$$\text{Mortality rate (\%)} = \frac{\text{Number of deaths during migration}}{\text{Total number of sheep at risk during migration}} \times 100$$

Collected data were compiled, tabulated for frequency and converted into percentage to draw inferences. Pearson's chi-square test was used to see the effect of age on disease incidence and mortality pattern. Pearson's correlation was done to find the association of flock size with disease incidence and mortality pattern. The difference was considered as statistically significant if $p < 0.05$ and data were analysed using SPSS version 16.

Results and Discussion

Shortage of feed and water resources in a particular area cause seasonal migration of shepherds. Although sheep migration is a traditional process in search of better feed and water resources, the migratory sheep flocks encounter several health problems during migration. These health problems are aggravated by the migration stress during en route migration which subsequently leads to death of the sheep. The present study discussed the migratory flock size, disease incidences, mortality pattern and problems faced by shepherds during en route migration.

Migratory sheep flock size

The size of migratory sheep flock was 160.4 ± 13.83 , which ranged from 70 to 310 sheep. Out of 20 shepherds, four had flock strength < 100 while thirteen had 100-200 sheep, two had 200-300 and one had only > 300 sheep. Geerling (2001) reported average size of migratory sheep flock 136 in arid region of Rajasthan but Rajanna *et al.*, (2012) reported small flock size (113.5) in migratory sheep in Andhra Pradesh. In Southern Tamil Nadu, it has been reported average flock size 137 and varied from 39 to 388 in different district (Kumaravelu *et al.*, 2008). The disparity of flock size may be due to distance

travelled by migratory flocks or due to the regional variation and status of the farmers' livestock holding capacity. It has been reported that flock size is directly associated with migration distance, flock with larger size follow longer distance migration as compared to smaller flock size (Garner *et al.*, 2000; Geerling, 2001; Balamurugan *et al.*, 2012). Migratory flocks travel short distance *i.e.*, about 75 km (51-199 km) in Andhra Pradesh (Rao *et al.*, 2011) and 171 km (54-360) in Tamil Nadu (Kumaravelu *et al.*, 2008) during migration, but in the present study, we followed the shepherds from Pali (Rajasthan) to Rahtak (Haryana) which covered around 600-700 km distance. Large flocks require more feed and fodder which leads to feed and fodder scarcity in local area and forced the shepherds to migrate longer distance; whereas for small flock it is not profitable as lot of costs is involved during migration for transportation, medication and livelihood etc. (Geerling, 2001; Suresh *et al.*, 2008).

Disease incidence

Disease incidence of sheep flocks during en route migration is depicted in table 1. The incidence of enterotoxaemia, FMD, sheep pox and PPR in migratory sheep flocks were 16.68, 9.26, 11.13 and 13.90%, respectively. Contrary to our results, higher incidence of enterotoxaemia (32%), FMD (34.9%), pox (42.6%) and PPR (63.5%) was observed by Garner *et al.*, (2000). Abd El-Rahim *et al.*, (2010) in Egypt also reported higher overall incidence of PPR (26.1%) in migratory flocks. The incidence of pox observed in the present study is in similar line with previous reports (Jindal *et al.*, 2006; Suresh *et al.*, 2008; Selvaraju and Balasubramaniam, 2013; Selvaraju, 2014), who reported that incidence of sheep pox ranged from 2.0 to 18.18% in different sheep flocks. We observed overall higher incidence of enterotoxaemia during en route migration may be due to overfeeding of grains during March and April in harvested

wheat field. In contrary to our results, Suresh *et al.*, (2008) reported about 2.14 times higher prevalence of FMD compared to enterotoxaemia (38.9 and 18.16%, respectively) in sheep flocks. The variation in disease incidences might be attributed to degree of contact with infected animals which is favoured by nomadism as it enhance spread of infection from infected animals to healthy animal due to contact during grazing or drinking (Garner *et al.*, 2000; Jindal *et al.*, 2006; Hegde *et al.*, 2009; Selvaraju and Balasubramaniam, 2014) in common grazing lands. Our study also revealed significant ($p < 0.05$) association of flock size with disease incidence (Table 3) and there was higher incidence of disease in flock with larger size may be due to inability of the migratory shepherds to isolate sick animals during migration from diseased animals which leads to spread of infection from diseased animals to healthy animals. Significantly ($p < 0.05$) higher incidence of diseases were observed in young ones compared to adult which is in agreement with previous studies (Abd El-Rahim *et al.*, 2010; Selvaraju and Balasubramaniam, 2013; Selvaraju, 2014). Selvaraju and Balasubramaniam, (2013) reported higher incidence of sheep pox in young sheep compared to their adult flock mates (10.99 vs. 1.36%, respectively). Similarly, Selvaraju (2014) observed five times higher incidence of sheep pox in young animals (22.7%) compared to the adult animals (4.59%). This may be explained by the fact that during migration the flocks encounter different stresses like migration stress, nutritional and climatic stress as observed in the present study. Such stress may leads to compromised immunity in young animals and decreases their disease resistance capabilities. During migration young ones are also not given proper care during lambing and also during their early life (Rao *et al.*, 2011) which may increase more susceptibility to infections agents.

Table.1 Incidence of diseases during *en route* migration

Diseases	Categories	Total animals	No. of positive cases (%)	Incidence range (%)
Enterotoxaemia	Overall	3208	535 (16.68)	5.00-21.25
	Adult	2123	267 (12.58)	1.54-27.0
	Young	1085	268 (24.70)	11.43-45.0
	χ^2 value	-	75.95***	-
FMD	Overall	3208	297(9.26)	2.78-17.36
	Adult	2123	142 (6.69)	1.54-14.17
	Young	1085	155 (14.29)	5.71-27.50
	χ^2 value	-	49.33***	-
Sheep pox	Overall	3208	357 (11.13)	3.33-20.83
	Adult	2123	187 (8.81)	1.54-18.0
	Young	1085	170 (15.67)	5.71-30
	χ^2 value	-	34.16 ***	-
PPR	Overall	3208	446 (13.90)	4.17-26.04
	Adult	2123	216 (10.17)	3.08-23.0
	Young	1085	231 (21.29)	5.71-43.33
	χ^2 value	-	73.98 ***	-
Abortion	Adult	2123	205 (9.66)	1.18-20.77

Parenthesis indicates percent; *** p<0.001

Table.2 Mortality rate during *en route* migration

Categories	Total animals	No. of animals died (%)	Mortality range (%)
Overall	3208	340 (10.60)	4.0 - 17.61
Adult	2123	124 (5.84)	1.33 - 12.93
Young	1085	216 (19.91)	10.0 - 35.0
χ^2 value	-	150.0***	-

Parenthesis indicates percent; *** p<0.001

Table.3 Pearson's correlation coefficient of association of flock strength with Disease incidence and mortality

Categories	Enterotoxaemia	FMD	Sheep pox	PPR	Abortion	Mortality
Total	0.66**	0.66**	0.68***	0.65**	-	0.59**
Adult	0.53*	0.53*	0.57**	0.5*	0.54*	0.52*
Lamb	0.74***	0.73***	0.77***	0.67**	-	0.52*

* p<0.05; ** p<0.01; *** p<0.001

The overall abortion of sheep flocks on en route migration was 9.66% which is in agreement with previous study by Kalla *et al.*, (2005), who reported 9.03% abortion in migratory sheep flock in Himachal Pradesh.

Further, Sharma *et al.*, (2008) observed that 25% of migratory flocks experienced 10% abortion losses per season and 56% of flocks had sporadic abortion losses (1 to 2%). In the present study, abortion cases ranged from

1.88% to 20.77% in different flocks with 13 flocks (65%) had abortion rate <10% and 7 flocks (35%) had >10% abortion rate which are more or less comparable with Sharma *et al.*, (2008). Like disease incidence, the abortion rate also significantly ($p<0.05$) and positively correlated with the flock size ($r=0.54$, Table 3). The abortion in migratory flocks mostly caused by infectious microbes (*Chlamydophila* spp., *Brucella* spp., *Listeria* spp. and *Salmonella* spp. etc.), which may spread easily by ingestion of feed and water contaminated with infected discharge and fetal membranes from aborted ewe (Sharma *et al.*, 2008) may be the reason of higher abortion in larger flocks. Abortion in migratory sheep may be aggravated by nutritional stress and compromised health. Kalla *et al.*, (2005) reported that abortion in migratory sheep can be reduced by 40% through supplementation of proper nutritional inputs (minerals and vitamins) and health input (deworming for both ecto and endo parasites and vaccination). The right time availability of medicines and Veterinary services during en route migration can reduce the incidence of abortion in migratory sheep flocks.

Mortality rate

During en route migration, mortality rate of young lambs was observed to be significantly ($p<0.001$) higher as compared to the adults (19.91 vs. 5.84%) with overall mortality rate of 10.60% (Table 2). In young lambs the mortality rate ranged from 10 to 35%; whereas, in adult it ranged from 1.33 to 12.93%, which are comparable with the previous reports (Garner *et al.*, 2000; Suresh *et al.*, 2008). Garner *et al.*, (2000) reported that mortality rate of small ruminants due to diseases ranged from 3.6 to 49.5% and they found pox as primary cause of mortality followed by PPR, enterotoxemia and FMD. Similarly, the overall mortality in sheep

flocks in Rajasthan has been reported to be 14% mainly due to enterotoxaemia and FMD by Suresh *et al.*, (2008). The outbreak of different diseases during en route migration as observed in the present study may be the contributing factor for mortality in migratory sheep flocks. Further, significant ($p<0.05$) and positive association of mortality rate with flock size (Table 3) may be due to spread of infection easily from sick animal to healthy animal as all animals kept together during migration without isolation of sick animals. Geerling (2001) reported that sheep pox, FMD, enterotoxemia etc. were common disease problems occurred in Raika shepherds but highest mortality in sheep flocks occurred due to sheep pox and reduced flock strength by half or even more. In similar line Abd El-Rahim *et al.*, (2010) reported significantly higher mortality of young animals in migratory flocks due to diseases problems in Egypt. Mortality rate was also observed more in young one in migratory sheep in Thar Desert of Rajasthan (Kataria *et al.*, 2007), Tamil Nadu (Thiruvankadan *et al.*, 2007) and Andhra Pradesh (Rao *et al.*, 2011). The higher mortality in young animals may be due to lack of proper care by their dams, migratory pattern of flocks, migration stress and lack of care during lambing. During extreme climatic conditions like severe hot and cold there is increase in young mortality in migratory sheep flocks because they could not receive any protection from adverse weather condition leading to disease susceptibility (Rao *et al.*, 2011). The higher mortality in young one might be attributed to higher prevalence of disease as young ones have poor immune system (Abd El-Rahim *et al.*, 2010; Selvaraju and Balasubramaniam, 2013; Selvaraju, 2014). During harvesting season of wheat (March-April) the damaged and wet grains are left in the wheat field and shepherds generally allow their young animals to eat. This may leads higher mortality in young animals due to

enterotoxemia or due to fungal toxin in wet grain. Higher rate of mortality during migration also associated with lack of availability of in time medicines and veterinary services as observed in the present study. Therefore, proper care of young ones and facilities of Veterinary services in en route migration could reduce the mortality of young animals and ultimately the overall mortality in migratory sheep flocks.

Constraints faced by shepherds

Constraints faced by shepherds during en route migration were fodder and water deficit, lack of medicines and Veterinary facilities, environmental stress, predators or wild animal problems and sometimes road accident. Nutritional stress and medicine availability ranked 1st position during migration as perceived by 95% shepherds. About 90% shepherds did not get veterinary facilities in time whenever any disease outbreak occurred during migration and ranked 2nd position. Further, problems of predators or wild animals (65%), environmental stress (50%), and road accidents (40%) were faced by shepherds during en route migration to a lesser extent.

The nutritional and climatic stress together with lack of veterinary services and medicine facilities are the important risk factors that increase disease outbreak and mortality rate in migratory sheep flocks. Road accident may be encountered while road side grazing or during travel through common roads used for public transport. In a similar line previous studies (Kumaravelu *et al.*, 2008; Suresh *et al.*, 2008; Rao *et al.*, 2011; Suresh *et al.*, 2011) also reported problems like veterinary facilities because most of the time the flocks were grazed at forest, around river beds and remote villages during migration. They also reported that during migration shepherds faced problems like restriction of grazing in forest area, water scarcity, threats from wild

predators and also sometimes road accident while grazing on road sides or while crossing the roads.

The results of the present study indicated that Enterotoxaemia is the major problem, occurred during migration. Young animals are more susceptible to diseases with higher mortality rate owing to nutritional and climatic stress along with lack of availability of medicines and Veterinary facilities. Therefore, reduction of nutritional and climatic stress and development of strategies for better health management such as facilities of medicines and health care would improve the health and welfare of sheep flocks during en route migration.

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