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Transhumance Effect on Husbandry Practices and Physiological Attributes of Chauri (Yak-Cattle) in Rasuwa District

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Abstract
This study was conducted in Rasuwa district, Nepal from 2008 to 2009 in Chauries (3 to 16 years) to analyze the transhumance effect in husbandry practices and physiological vitals. Physiological vitals were evaluated by 2×4 Factorial CRD with two levels of altitude (high- 3300 m and low- 1655 m) and four levels of age group (G_1- ≤6 yrs, G_2- 7 to 9 yrs, G_3- 10 to 13 yrs and G_4- >13 yrs); information regarding husbandry practices were collected from herders (n=60) using semi-structured questionnaire. Physiological vitals were taken from two altitudes, then analyzed for two- way ANOVA by Mstat- C and survey data by SPSS 16.0. Husbandry practices were found to be almost similar round the year except the matter of herbage supplementation during winter and early parturition. Rectal temperature, respiration rate, pulse rate and DSI showed significant increase ($P<0.01$) when animals were at low altitude pasture. Therefore, findings of this study revealed that transhumance system of Chauri management is herders' rational farming approach to make use of available pastures at different altitudes and have a distinct impact on rearing system and animals' physiology.

***Key words*:** Transhumance, Chauri, husbandry practices, Dairy Search Index

Introduction

Chauries, the crosses of yak (*Bos grunniens L.*) and local hill cow (*Bos indicus*) or Tibetan yellow cattle (*Bos taurus*) are confined in high hills and mountainous districts of Nepal, mostly above 2000 m (Joshi, 1982; Pradhan *et al.,* 2000). Chauries are genetically superior and productive than either parent due to hybrid vigor and are more adaptive to lower altitudes; so, are reared at the intermediate zone of zebu cattle and yak, at around 1500-5000 m on transhumance system (Joshi, 1982; Miller, 1987; Pal *et al.,* 1994; Merkle, 2000; Gurung and McVeigh, 2002). Hybrids with yak are produced with the humpless dwarf cattle of Tibet known as Khirko, Nepalese indigenous hilly cattle as Lulu and Siri hill cattle (Joshi, 1982; 2003).

The husbandry practices and physiological vitals of animals are influenced by various factors such as age, season, environment, work load, physiological condition of animals etc. The effect of age (Xueguang *et al.,* 1994; Sarkar *et al.,* 1999a), lactation (Sarkar *et al.,* 1999b), parturition (Sarkar *et al.,* 1999c) and pack (Mondal *et al.,* 1997) on serum biochemistry of yak and their hybrids had

been described in Indian and Chinese context. Similarly, variations in biochemical parameters due to sex were also reported (Xueguang *et al.,* 1994; Sen, 1997; Chatterjee *et al.,* 2004a; Chatterjee *et al.,* 2004b). However, information on transhumance influence on various physiological vitals is grossly lacking. Physiological responses to different environments during transhumance too need to be addressed precisely, so that associated problems could be identified in order to help the overall management and uplift the production performances. Initiative had been found to be taken by Sarkar *et al.* (2000) in Indian yak but is completely lacking in context of yak-cattle or Chauri.

Transhumance is a rule of management, not an exception; so, most of the physiological indices tend to vary during transhumance as altitude, grazing environment and feed type changes abruptly in the process and no single index at specific pasture can work as a reference value applicable to whole pasture range where Chauri naturally remains. This paper describes the transhumance effect on husbandry practices and physiological vitals of chauri.

Materials and methods

The study was conducted in Dhunche and Syaphru VDCs, Rasuwa district, Nepal, from September, 2008 to March, 2009 in two phases: (a) A field survey on existing Chauri husbandry practices and (b) Biological study with analysis of physiological responses of Chauri under different pasture.

Field survey was conducted using semi-structured questionnaire among 60 Chauri herders to collect information focusing on Chauri rearing system, production performances, health and managemental hindrances, breeding traditions and knowledge, pasture composition and problems in their traditional way of supplementing livelihood system. The laboratory study was laid in 2×4 factorial CRD with factors (a) Altitude- high (3300 m) and low (1655 m) and (b) Age groups- G_1 (≤6 yrs), G_2 (7- 9 yrs), G_3 (10- 13 yrs) and G_4 (>13 yrs). 28 Chauries of 3-16 years age were selected randomly from different Chauri herds, grouped into four different age groups as G_1, G_2, G_3 and G_4. Then, these animals were used as sample source both at high and low altitude pasture. Physiological responses like Rectal temperature (ºC), Respiration rate (bpm) and Pulse rate (bpm) were recorded twice daily at 7.00-8.00 morning and 4.00-5.00 evening regularly for three days and their average were used for analysis. Evening observations were recorded about 30 minutes following return to eliminate the grazing effect. From these data, Dairy Search Index (DSI) was determined by following equation for each animal as described by Bonsma (1949):

$DSI = DSI = 0.5 \times X_1/X + 0.2 \times Y_1/Y + 0.3 \times Z_1/Z,$

Where X_1, Y_1 and Z_1 are the observed rectal temperature (ºC), respiration rate and pulse rate, respectively. X, Y and Z are normal rectal temperature, respiration rate and pulse rate which are 38.33 ºC, 23 bpm and 60 bpm, respectively.

Data were analyzed for ANOVA by Mstat- C (version 1.3 Michigan University, 1994). Mean comparison were done by using DMRT and LSD at 5% level of

significance. Survey data were analyzed by SPSS 16.0 Stastical Software Package, 2007 (SPSS Inc., Chicago).

Results and discussion

Migration Tract

Transhumance, seasonal migration of herds between different but complementary ecological points, summer pastures in the mountains and winter pastures in the lowlands, is key grazing pattern and it is a recurrent feature of indigenous grazing management systems in Syaphru and Dhunche VDCs, Rasuwa, Nepal, mainly to exploit seasonal availability of pasture. Transhumance system, characterized by diversity and mobility to minimize risk in unpredictable conditions is an ecological reality and a good indicator of rangeland health. Based on the climatic conditions, ritual beliefs, herbage need and availability of pasture land; the herders have established different herding tract and pastures for grazing their Chauries. The animals move towards high altitude alpine pastures in the monsoon season and to lower pastures, fallow lands or community forest near settlement during the winter (Fig. 1). In Dhunche, the farmers settle in the lowland and herd their livestock in vertical transhumance from the community forest (about 1700 m msl) surrounding their settlements in winter to Lauribinayak pasture (about 4300 m in altitude) in summer. In Syaphru, the farmers settle close to their community oak forestry (about 1800 m) for winter grazing and herd their Chauri herds in ascending transhumance to Lauribinayak pasture for summer grazing.

Herd and feeding management information

Chauri herding is the tradition, farmers being on this herding profession since long back, some herders gave history of Yak and Chauri herding since 8th generation back but herd size are in decreasing trend in comparison to figures, a decade back. Most herders were found to have less than 20 animals and only few farmers with more than 30 animals (Tab. 1). The decreasing herd size was mainly because of family splitting and decreasing available pasture lands. McVeigh (2004) described similar herd size and its decreasing trend in Lantang valley, Rasuwa. Similarly, Pande (2004) described average herd size of 17.60 in Sindhupalchowk district with decreasing trend from 20 to 25 animals five years back but Shrestha *et al.* (1996) reported 6.5 animals herd size. Chauries were housed on open roof system, with some temporary fencing only on some predator prone regions, round the year on absolute grazing with no supplementations except offering a handful of salt once daily. But, in winter, almost half farmers were found to supplement extra fodders like straw, hay, vegetable leftovers, whey etc. to milking animals. Most herders were found to supplement good quality feeds to milking animals as succulent roughages, cereals and extra salts as Joshi (1982, 2003), Pradhan *et al.* (2000) and Pande (2004) described earlier.

Production performances and reproductive characteristics

Average first calving age of chauri is

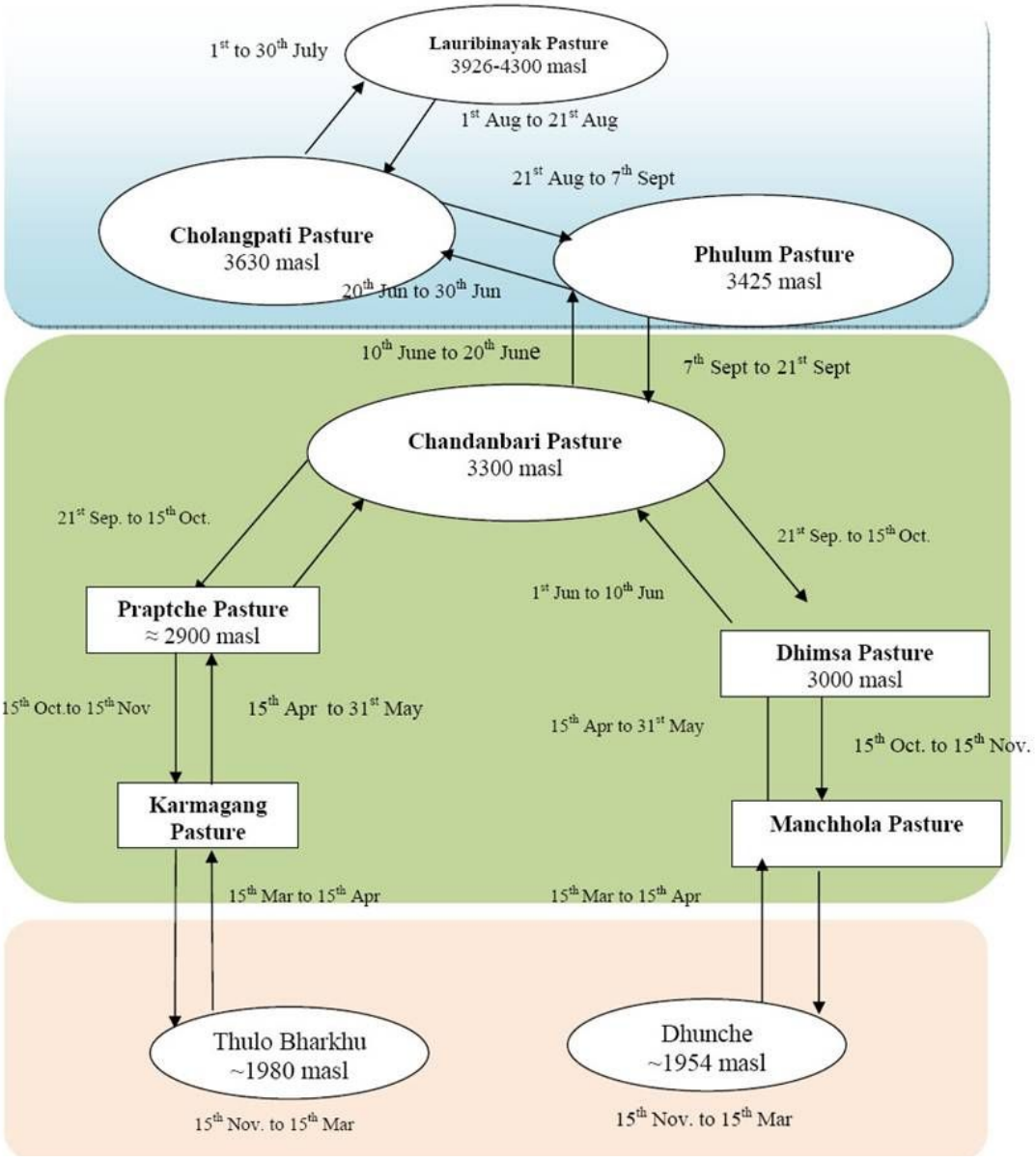

Figure 1. Transhumance tract and its traditional calendar in Dhunche and Syaphru VDCs, Rasuwa district.

extrapolated to be 3.07 years with majority of animals to calve first at 3 years of age and more than half was found to have lactation period of 6 to 7 months. The lactation length is extremely short in Yak and Chauri because of the harsh environmental condition and extreme feed scarcity they have to cope with, on low

altitude pasture during winter. Animals were reported to lose up to 20-25% of their body weight in winter pasture (FAO, 2003). Similar studies of Yak and Chauri by Joshi *et al.* (1994) and Pande (2007) described almost same figure of first calving age as 35 months and 3 years but they accounted average lactation period to be 254 to 400 days. However, Shrestha *et al.* (1996) described a higher first calving age (3.94±0.09 years) of Chauri. Animals were found to be in production for 20 to 22 years and were weaned at less than 15 days age. If calves are expected to be superior and herder wishes to keep it as future chauri, then he weans at around 4 months. Similarly, majority of animals were found to have 13 to 14 months calving interval as was described earlier by Joshi *et al.* (1994), Shrestha *et al.* (1996) and Pande (2007) for dimzo and urang Chauri. However, Paudyal (1995) and Neopane *et al.* (1999) had described calving interval of 1.7 years and 1.53±0.48 years respectively, quite longer than this finding. Regarding production performances, Chauries were observed to produce 1 to 4 liters of milk; which are all purchased and used by Cheese Production Center from Baisakh (April/May) to Kartik (Oct/Nov) for cheese and butter production; milk on remaining months are used for household consumption, for ghee, butter and chhurpi (hard cheese) preparation (Tab.2).

Health care and management

Herders were found to have basic knowledge on common diseases such as FMD, BQ, HS, and Mastitis; were aware on importance of anthelmintics use but none herders were found to drench their herds in routine (Tab.3). Similar facts had been reported by Degen *et al.* (2007) with only one Yak and Chauri herder to practice drenching and dipping twice yearly in Mustang district, Nepal. Farmers were in favor of indigenous knowledge of herbal preparation as ectoparasiticidal remedies and were found to rely on different locally available plant extracts for this purpose. Ectoparasites are the problem when Chauries come down to lower altitude pasture in winter season and share grazing land with low altitude livestock species. Traditional healers or Amchi were well accepted livestock worker in Chauri herding highlands, where access of veterinarians and paraprofessionals were hard to expect, which might be the fact that none animals were found vaccinated against any diseases. Degen *et al.* (2007) also reported similar facts about vaccination in Yak and Chauri herds in Mustangi herders with no animals vaccinated against any disease.

Table 1. Information on herd and feeding management of Chauri (n=60) in Rasuwa, 2008.

Description	Categories	No. of Farmers (%)
History of chauri keeping	From generations back	59 (98.33)
	Few years back	01 (01.67)
Herd size	Above 30	18 (30.00)
	20-30	16 (27.00)
	Below 20	26 (43.00)
Shed used	Open roof system	56 (93.33)
	Temporary shed	04 (06.67)
Feeding management	Only grazing	52 (86.67)
	Grazing, cereals, whey, brewery leftovers etc	08 (13.33)
Feeding in lean season	Grazing	32 (53.33)
	Straw/hay, whey and grazing	28 (46.67)
Supplementation for increasing milk yield	No	26 (43.33)
	Green roughages + cereals + salt	34 (56.67)

Table 2. Information on production performances, reproductive characteristics and postproduction use of Chauri (n=60) in Rasuwa, 2008.

Description	Categories	No. of farmers (%)
First calving age	3 years	51 (85.00)
	4 years	09 (15.00)
Lactation period	6 to 7 months	35 (58.33)
	7 months	12 (20.00)
	Above 7 months	13 (21.67)
Average productive age	Above 22 years	03 (05.00)
	20 to 22 years	41 (68.33)
	Below 20 years	16 (26.67)
Weaning age	Above 1.5 months	13 (21.67)
	0.5 to 1.5 months	19 (31.67)
	Below 0.5 months	28 (46.67)
Calving interval	13-14 months	55 (91.67)
	15-16 months	05 (08.33)
Average milk yield per day	2 to 4 liters/day	29 (48.33)
	2 to 3 liters/day	20 (33.33)
	1 to 2 liters/day	11 (18.33)
Milk use pattern	To DDC (April/May-Oct/Nov) and as ghee and Chhurpi in other months	60 (100.00)

Table 3. Distribution of variables associated with health care and consciousness about diseases and vaccines of Chauri (n=60) in Rasuwa, 2008.

Description	Categories	No. of farmers(%)
Knowledge on diseases common to Chauri	Yes	39 (65.00)
	No	21 (35.00)
Anthelmintics use pattern	No	07 (11.67)
	Allopathic	14 (23.33)
	Ethno-herbal	19 (31.67)
	Both	20 (33.33)
Acaricide use pattern	Malathion and others	15 (25.00)
	Ethno-herbal	45 (75.00)
Diseases and problems consulted and treated with	Veterinarians and Para-veterinarians	03 (05.00)
	Amchi or Traditional healers	22 (36.67)
	Both	35 (58.33)
Knowledge on vaccines	Yes	05 (08.33)
	No	55 (91.67)

Herders' knowledge on pasture species and sires

All herders had excellent knowledge on different poisonous and milk off- flavoring plants common on their pasture lands. The pasture species those are poisonous to Chauri and other livestock species, as identified by herders, are *Sirmorba*, *Chyom*, Fern, Mushroom, *Murba* and Gandhe. Similarly, Titepati (*Artemisia biennis*), Chiraito (*Swertia* sp.), Chyom, Bojo (*Acorus calamus*), Gandhe (*Ageratum houstonianum*), Jimbu (*Allium fasciculatum*) etc. are the common milk tainting plants. Tibetan yellow cattle (Bhelang in local term) were preferred more as a sire for Yak and Chauri breeding, but use of local hilly bull is being common because of ease of availability (Tab.4). The availability of pure Tibetan yellow cattle is decreasing after closure of Tibetan border, so sharing of breeding sires among different Chauri herds are common practice in Syaphru and Dhunche VDCs. Herders pointed out pasture land deterioration and increased disease prevalence as the main problem.

Basic physiological vitals

Mean rectal temperature, respiration rate, pulse rate and DSI were found significantly higher ($P<0.01$) in animals at low altitude pasture (Tab. 5). This might be due to the fact that low altitude pasturelands were atypical to Chauri from temperature view point which develops some sort of stress and this condition is again aggravated by prolonged shortage of herbage biomass. Therefore, animals were reported to lose up to 20-25% of their body weight at low altitude pasture during winter season (FAO, 2003). It is obvious that any imbalance in

heat production and loss, which cannot be precisely handled by the thermoregulatory mechanism, is reflected by an increase in body temperature and then increase in other physiological responses to cope with accumulated heat in body.

Table 4. Distribution of variables associated with knowledge on poisonous plants, bull preferences and common husbandry constraints of Chauri (n=60) in Rasuwa, 2008.

Description	Categories	No. of farmers (%)
Knowledge on poisonous plants	Yes	60 (100.00)
	No	-
Knowledge on milk tainting plants	Yes	60 (100.00)
	No	-
Type of bull used for breeding	Tibetan yellow cattle or Bhelang	43 (71.67)
	Local bull	08 (13.33)
	Both	09 (15.00)
Constraints in Chauri husbandry	Pasture land scarcity and diseases	44 (73.33)
	Bull scarcity and increasing poisonous plants	16 (26.67)

Similar to this finding, Sarkar *et al.* (2000) described higher rectal temperature in moderately cold humid season or low altitude pasture in yak. Li (1981) too described similar facts of rising body temperature above an ambient temperature of 13°C-16°C and when it reaches 20°C, yak looks for shade without moving, grazing, drinking or ruminating. But, at the other extreme, it can feed and move normally at ambient temperatures ranging as low as -30°C to -40°C. With respect to respiration rate, this finding is in agreement with Sarkar *et al.* (2000) who described a significant rise in respiration rate in moderately cold humid season or low altitude pasture range in yak. Li (1975) observed respiration rate 20-30 per minute at 13°C, but above that temperature it increased rapidly in yak.

Table 5. Mean rectal temperature, respiration rate, pulse rate and dairy search index value of Chauri in relation to altitude and age groups in Rasuwa, 2008 (n=28).

Treatments	Parameters			
	Rectal Temp. (°C)	Resp. Rate (/min)	Pulse Rate (/min)	(DSI)
Altitude				
High (3365 m)	38.69[a]	19.78[a]	57.1[a]	0.96[a]
Low (1655 m)	38.97[b]	48.37[b]	72.30[b]	1.29[b]
P value	**	**	**	**
Age				
G1 (Upto 6 yrs)	38.77	33.55	64.52	1.12
G2 (7-9 yrs)	38.85	33.02	64.84	1.12
G3 (10-13 yrs)	38.80	33.66	64.61	1.12
G4 (>13 yrs)	38.90	36.05	64.98	1.15
P value	Ns	Ns	Ns	Ns
Altitude Age combined effect				
High, G1	38.67	19.54	57.61	0.96
High, G2	38.69	19.39	57.68	0.96
High, G3	38.66	20.00	56.82	0.96
High, G4	38.73	20.18	56.57	0.96
Low, G1	38.87	47.57	71.43	1.28
Low, G2	39.01	46.64	72.00	1.28
Low, G3	38.94	47.32	72.39	1.28
Low, G4	39.06	51.93	73.39	1.33
P value	Ns	Ns	Ns	Ns
CV%	0.34	12.52	3.94	3.75

**Highly Significant at P<0.01, Ns non significant at P>0.05, Means with different letter superscripts within column within each treatment differ significantly at P<0.05.

Zhang (1989) reported a respiration rate in adult yak of 80/m at 28°C, 49/m at 10°C and 25/m at 5°C. Pulse rate in this study was observed to differ significantly in high and low altitude animals, which is in agreement with Sarkar *et al.* (2000) in yak. However, Zhao (1982) reported highest

pulse rate in June, i.e., at high altitude on transhumance system and a gradual decline after the warm season ends. Dairy search Index (DSI) figure too was in agreement with Sarkar *et al.* (2000) who described a significant increase in DSI value in yak at low altitude pasture indicating a decrease in thermal adaptability as it was much deviated from '1' as compared to value at high altitude pasture.

However, all the physiological responses were found to vary non-significantly ($P>0.05$) and were within the normal physiological range as referenced for bovids with respect to age group of chauri and in all treatment combinations.

Conclusion

Current Chauri husbandry needs a rational intervention in order to move this traditional farming approach in line with 21st century's livestock keeping principle. Physiological attributes are a matter of great variation during transhumance and figure obtained from this study can work as a reference data for chauri health management and therapeutics in Nepalese context.

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References

Bonsma, J. 1949. Breeding cattle for increased adaptability to tropical and subtropical environment. *Journal Agricultural Science* ***39*****:** 204-221.

Chatterjee, A., R. Pourouchottamane, D.N. Das and M. Sarkar 2004a. Some serum biochemical parameters in yak (*Poephagus grunniens*). *Indian Journal of Animal Science* ***74(1)*****:** 53-55.

Chatterjee, A., R. Pourouchottamane, M. Sarkar and M. Bhattacharya 2004b. Serum macro-mineral profile in female yak grazed on winter pasture. In: *Yak production in central Asian highlands Proceedings of the Fourth International Congress on Yak*, 2004- Chengdu, China. (Eds. Z. Jincheng, Z. Xiangdong, H. Jianlin and C. Zhihua). International Livestock Research Institute (ILRI), Nairobi, Kenya.

Degen, A.A., M. Kam, S.B. Pandey, C.R. Upreti, S. Pandey and P. Regmi 2007. Transhumant pastoralism in the lower Mustang district. *Nomadic peoples* ***11(2)*****:** 57-85.

FAO 2003. *The yak*, 2nd edition. (Eds. G. Wiener, J. Han and R. Long). Regional office for Asia and the Pacific, RAP Publication, Food and Agriculture Organization, Bangkok. pp. 61-82.

Gurung, G. and C. McVeigh 2002. Pastoral management and yak rearing in Manang's Nar and Phu valley. In: *Yak production in central Asian highlands. Proceedings of the 3rd International congress on yak held in Lhasa, P.R. China*, 4-9 Sept 2000. (Eds. H. Jianlin, C. Richard, O. Hannotte, C. McVeigh and J.E.O. Rege). International Livestock Research Institute (ILRI), Nairobi, Kenya. pp. 104-119.

Joshi, D.D. 1982. *Yak and Chauri husbandry in Nepal*. HMG Press, Kathmandu, Nepal. 145p.

Joshi, D.D. 2003. Yak in Nepal. In: *The yak, 2nd edition*. (Eds. W. Gerald, J. Han and R. Long). Food and Agriculture Organization, Regional office for Asia and the Pacific, RAP Publication, Bangkok, Thailand. pp. 316-322.

Joshi, D.D., P.N. Lund, D.J. Miller and S.K. Shrestha 1994. Yak production in Nepal. In: *Yak production in central Asian highlands* (Eds. Z. Rongchang, H. Jianlin and W. Jianping). Proceedings of the 1st international congress on yak held in Lanzhou, P.R. China, 4-9 September 1994. Supplement of J. Gansu Agric. Uni., Lanzhou. Printing house of Gansu economic management cadre institute, China. pp. 105-112.

Li, C. 1975. Determination of physiological and biochemical indexes in yak. *Journal of Chinese Animal Science* ***6*****:** 29-31.

Li, S. 1981. The preliminary observation on yak's heat resistance. *Journal of China Yak* ***2*****:** 1-4.

McVeigh, C. 2004. Himalayan herding is alive and well: the economics of pastoralism in the Langtang valley. *Nomadic peoples* ***8(2)*****:** 107-124.

Merkle, R. 2000. Nomadism: A socioecological mode of culture. In: *Yak production in central Asian highlands* (Eds. H. Jianlin, C. Richard, O. Hannotte, C. McVeigh and J.E.O. Rege). Proceedings of the 3rd international congress on yak held in Lhasa, P.R. China, 4-9 September, 2000. International Livestock Research Institute (ILRI), Nairobi, Kenya. pp. 128-133.

Miller, D.J. 1987. *Yaks and grasses: pastoralism in the Himalayan countries of Nepal and Bhutan and Strategies for sustained development*. University of Montana, Missoula, Montana. (Masters Thesis)

Mondal, D.B., R.N. Pal, S.K. Barari, T.K. Mohanty and U.A. Nandankar 1997. Effect of normal haematophysiology due to pack on yaks- a preliminary study. In: *Yak production in central Asian highlands* (Eds. Y. Rongzhen, H. Xingtai and L. Xiaolin). Proceedings of the 2nd Int. Congress on Yak held in Xining, China, 1-6 Sep., 1997. Qinghai People's Publishing House, Xining, P.R. China. pp. 204-207.

Neopane, S.P., P.K. Pokharel and S. Shrestha 1999. Evaluation of productive performance of Yak at Solukhumbu. In: *Proceedings of the 3rd National Workshop on Liv. and Fisheries Research in Nepal* (Eds. S.P. Neopane and R.C. Khanal). 26-28 June, 1999. NASRI, Nepal.

Pal, R.N., S.K. Barari and D. Biswas 1994. Yak (*P. grunniens*) husbandry in India. In: *Yak Production in Central Asian Highlands* (Eds. Z. Rongchang, H. Jianlin and W. Jianping). Proceedings of the 1st Int. congress on yak held in Lanzhou, 4-9 Sep., 1994. Supplement of J. Gansu Agric. Uni., Lanzhou, China. pp. 16-21.

Pande, R.S. 2004. Chauri production systems in upper slope areas, Sindhupalchok, Nepal. In: *Yak Production in Central Asian Highlands* (Eds. Z. Jincheng, Z. Xiangdong, H. Jianlin and C. Zhihua). Proceedings of the Fourth International Congress on Yak, 2004- Chengdu, China. International Livestock Research Institute (ILRI), Nairobi, Kenya.

Pande, R.S. 2007. Yak farming in Nepal. Nepalese Agricultural Information. Kathmandu, Nepal. http://atoz-nepal.blogspot.com/2007/03/yak-farming-in-nepal.html [Retrieved 4th Sep., 2009].

Paudyal, R.M. 1995. Basic physiological parameters of the Yak and Chauri: A review. *Veterinary Review* ***10(2)*****:** 10-14.

Pradhan, S.L., D.K. Hitchcock and D. Miller 2000. Yak hybridization in the upper slope region of Nepal: A community resource management strategy. In: *Yak Production in Central Asian Highlands* (Eds. H. Jianlin, C. Richard, O. Hannotte, C. McVeigh and J.E.O. Rege). Proceedings of the 3rd Int. Congress on Yak in Lhasa, P.R. China, 4-9 September, 2000. International Livestock Research Institute (ILRI), Nairobi, Kenya. pp. 146-157.

Sarkar, M., B.C. Das, D.B. Mondal and A. Chatterjee 2000. Physiological responses of yak under different environments. In: *Yak Production in Central Asian Highlands* (Eds. H. Jianlin, C. Richard, O. Hannotte, C. McVeigh and J.E.O Rege). Proceedings of the 3rd International Congress on yak held in Lhasa, P.R. China, 4-9 September, 2000. International Livestock Research Institute (ILRI), Nairobi, Kenya. pp. 388-392.

Sarkar, M., B.C. Das, D.B. Mondal, D.N. Das, T.K. Mohanty, B.P. Singh, R.N. Pal and S. Ray 1999c. Haemogram in yak (*P. grunniens*) during parturition. *Indian Journal of Animal Science* ***69(1)*****:**32-33.

Sarkar, M., B.C. Das, D.N. Das, D.B. Mondal and T.K. Mohanty 1999a. Studies on haematology of yaks (*P. grunniens*) from birth to one year of age. *Indian Journal of Animal Science* ***69(10)*****:** 800-802.

Sarkar, M., D.N. Das, B.C. Das, D.B. Mondal, T.K. Mohanty and B.P.S. Yadav 1999b. Influence of lactation on the haemogram of yak (*P. grunniens*). *Indian Journal of Animal Science* ***69(8)*****:** 588-589.

Sen, M. 1997. Physiological and biochemical parameters and potassium phynotype in the blood of Qinghai White Yak. In: *Yak production in central Asian highlands* (Eds. Y. Rongzhen, H. Xingtai and L. Xiaolin). Proceedings of the 2nd

International Congress on Yak held in Xining, P.R. China, 1-6 September 1997. Qinghai Peoples Publishing House, Xining, P.R. China. pp. 210-212.

Shrestha, B.S., K.S. Kshatri, N.P. Shrestha and L. Sherchand 1996. Morphological characteristics and productive and reproductive performance of Yak/Nak. In: *Proceeding of the 1st National Workshop on Livestock/Fisheries Research in Nepal* (Eds. B.S. Kuwar and H.R. Shrestha). May 7-9, 1996. NASRI, Lalitpur, Nepal. pp. 73-80.

Xueguang, M., W. Guihua, Q. Qi, Xinai and S. Boaxin 1994. The physiological and biochemical constants of Xinjiang Bayingilon Yak. In: *Yak production in central Asian highlands* (Eds. Z. Rongchang, H. Jianlin, W. Jianping and C. Yanhong). Proceeding of the 1st International Congress on Yak in Gansu Agriculture University, China, 1-6 August, 1994. Supplement of J. Gansu Agric. Uni., Lanzhou. Printing house of Gansu Economic Management Cadre Institute, China. pp. 272-275.

Zhang, R. 1989. *Yak of China*. Lanzhou- Gansu Science and Technology Publishing House. pp. 75-194.

Zhao, B. 1982. Study on the three physiological indexes of yak. *Journal of China Yak* ***4*****:** 24-30.