



Development and Evaluation of Improved Saddle of Yak for Enhancement of Pack-load Capacity on Steep Slopes in Hills -A Case Study in NER

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ABSTRACT

The Yak rearing states of India are Arunachal Pradesh, Sikkim, Himachal Pradesh and Jammu and Kashmir. The total number of Yaks were 65000 (Indian Livestock Census 2003) in India including 7000 in Sikkim. There were number of phenotypic types among Indian Yak. The common Yak resembled medium size hill cattle in conformation. Bisonian Yak were found as bigger animals having bare back, long body and little hair on their backs. Among the ten colour patterns available in India, the majority were black (29%) and black with white patches (40%). Some are of brown with white patches. Yak in Sikkim are generally used as pack animals for transport of goods and for riding and trekking. Yak is an important animal in high hills and snow bound areas due to their unique ability to survive in extreme cold climates. Yak is the main-stay for the highlander's dwellings in mid and higher reaches of Sikkim providing transport. In Arunachal Pradesh (District: West Kamrang, location Derang hills), the local yak (weight :350 kg) using traditional saddle (weight : 4.7 kg) showed pack load capacity of 80 kg negotiating 60% slope for travelling 3 km in one hour duration. The respiration rate, pulse rate of yak (weight: 350 kg, age: 3 years) increased 17% and 26% respectively for covering one km distance slope negotiating 60%. The test trial of developed improved saddle (weight: 3.2 kg) made using composite material was conducted at Thangu region (Altitudes 4270 - 4800 m) in north Sikkim district. The maximum pack load of 120 kg (three bags of potato each of 40 kg weight) on yak could be transported covering 5.5 km distance (travel speed : 2.62 km/h) in two hour duration at steep up slope of 60 degree. It showed that newly developed saddle was able to take 30% more load over traditional saddle. The physiological responses (respiration rate/min, pulse rate/min and body temperature in °C) were measured before and after the test trial. The result showed that respiration rate, pulse rate and body temperature were increased by 22%, 31% and 1.7% during two hours trial. The improved design of saddle provided higher work output besides comfort to the animals. Replacement of saddle materials was considered keeping in view the cost-effectiveness, light weight, cushioning effect with lower body surface friction and easy availability and affordability.

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1. Introduction

The Yak population in India was reported to be 0.46% of the world. Yaks are multipurpose animal adapted between 3000 to 6000 m above mean sea level of the 14.2 million domesticated yaks in the world. About 65000 yaks were found in India. There were 9000 yaks in Arunachal Pradesh and 7000 in Sikkim hill tracts. In India the population of male and female ratio of pure yak was 1:0.82 in Himachal Pradesh. The average herd size of each household varied from 5 to 100 animals. During summer, yaks moved to high altitude alpine pasture (4500 m and above). In winter, the animals returned to pockets nearer to their villages located at mid altitude (3000 m above msl). Yaks lost body weight 25-30% during winter due to inadequate fodders. Shearing of yak normally performed once in a year. Yak produced about 0.5-1.5 kg of coarse hair and 250-750 g of fine hair per year. Shearing of tail hair was done once in two years yielding about 500-600 g per yak. Yak hair fiber products were water proof and very durable. (Anonymous 2011). The camels could carried a pack load of 50 kg continuously for 5 h, 150 kg for 3.5 h and 200 kg for 3 h sandy track while they were able to carry about 1600 kg in camel cart on sandy track and 2000 kg on *tar macadam* and *kuchha* roads. Studies conducted at Udaipur and Raichur centres showed that donkeys succeeded in carrying a pack load of 20-30 kg for 2-3 h, 50 kg for 2 h and 70 kg for 1 h (Singh 1999). Yak in Sikkim are generally used as pack animals for transport of goods and for riding and trekking. Yak is an important animal in high hills and snow bound areas due to their unique ability to survive in extreme cold climates. Yak is the main-stay for the highlander's dwellings in mid and higher reaches of Sikkim providing transport. It was planned to utilize efficiently to these animals by developing suitable harness, saddle and other required fixtures. Rotary mode application of Yaks for electricity generation and post harvest operations may reduce the hardship of people owning Yaks.

There appeared great potential for harnessing Yak energy may be used effectively which would help the dependent users in other North East Hill regions having Yaks (Anonymous 2010).

2. Materials and Methods

The College of Agricultural Engineering and Post Harvest Technology (Central Agricultural University) Ranipool centre of All India Coordinated Research Project on Increased Utilization of Animal Energy with Enhanced System Efficiency, Ranipool-Sikkim carried out survey on yak utilization at Kupuk in east Sikkim. The people owning Yak showed their willingness to use the animals in rotary mode for electricity generation and post harvest operations during the idle period (3 months). It was informed that for riding purpose few Yaks (20 numbers) were used almost for nine months in a year. Leather saddle was used almost horse riding was generally used having overall dimensions of 450 x 320 mm. The average weight of the saddle unit (known as Texan zen) was 4 kg. They opined that improved design of saddle should have comfort to the Yak and material replacement with cushioning effect should ensure for light weight and durability of saddle. The developed unit should be comparatively lesser in weight, cost effective and increase pack load transport capacity by reducing friction between the body of animal and saddle. It was informed that after two years of age of Yak nose holes were made to pass the hitch rope through it for the control of Yaks in operation. The price of adult Yak (6 years) varied from Rs. 8000 to 10000/- (2009-10). On daily diet of single Yak, individuals normally incurred expenditure of Rs. 80-100/- The composition of Yak feed consisted of Chickpea, wheat flour and green grasses. The Yak shed were generally constructed having size of 8 x 6 m to house 8-10 Yaks. These sheds were also used for milking purpose (milk capacity 2-4 kg/day). The unit price of the saddle used in Kupuk region was Rs. 600/-.

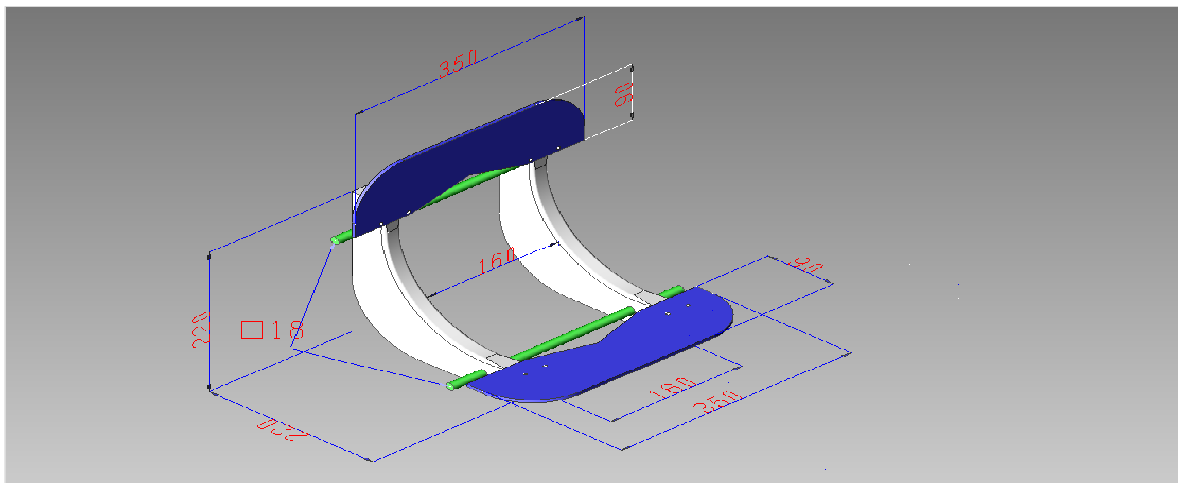


Figure 1. CAD of Traditional saddle for Yak (dimensions in mm)

The pack load values on Yak at the age of 2, 3, and 4 years of age were reported as 50, 75 and 120 kg, respectively. For 100 kg pack load transport on Yak for 2 km distance negotiating 1000-2000 m altitude the charges varied from Rs. 100 to 150/-. The weight of single adult Yak of 6-7 years of age varied 400-500 kg. The average length and height of Yak were 2100 mm and 1400 mm with hump height of 1560 mm. The girth of Yak measured was 2050 mm. The average periphery of hoof was 360 mm and total length of leg was 750 mm. These body dimensions helped in improving the design of harnesses and Yak gadgets. The north district of Sikkim was having maximum yak population (3877). The second survey in Yak region of Sikkim was carried out near the Yak breeding centre at Zeema, Lachen block in North Sikkim at 330 m altitude during winter.

It was found that one male yak bought from Bhutan for breeding purpose and it was larger (600 kg) in size compared Sikkim male yaks. The physiological parameters at rest were recorded along with feed schedule and diet. The CAD drawing of the traditional saddle viewed in Zeema, Lachen region was given in Figure 1. The view of pebbles made from rich nutrients (concentrate) were found effective in enhancing pack load capacity as shown in Figure 2. In north district of Sikkim near Zeema, local yaks were used for transport of household commodities (rice, *atta*, *dal*, sugar and other items) with traditional saddles by army and civilians on steep slopes. The yaks of north Sikkim (Zeema) were engaged for transport of household items and military ration for 10-15 km distance in 08-10 h on slope varying from 50 to 60 degree on hilly track using traditional carrying saddle and packload of 60-75 kg.



Figure 2. Traditional saddle for yak used in Derang



Figure 3. Energy Pebbles as feed concentrate for yak



Figure 4. Saddle used by army on steep slope



Figure 5. Pack load capacity study on yak



Figure 6. Physiological parameters measurements of yak



Figure 7. Explaining composite material for improved saddle for yak

For planning the efficient management strategy of yak, The National Research Centre on Yak, (ICAR) Derang, district-West Kamrang, Arunachal Pradesh was visited to assess the status of utilization of Yaks in steep slopes at higher altitudes and utilization of their by-products. The hair was used for making *chanwar* (used in holy places), caps, foot-mats, door-mats, blankets, ropes, wool and other items for human use. The breeds of Yak, body wt., size, annual use, daily feed intake per yak, milk production, housing structure, daily unit operations for maintenance/up keeping operations, meat yield, speed of yak, traditional saddle used in steep slope for pack load transport, load transported in traditional system, physical and physiological responses (body temperature, pulse rate and respiration rate) before and after the pack-load transport on slope were recorded during test trials for 3 km travel distance.

The saddle used by army in Derang consisted of iron frame, leather and thick cotton pads. One saddle of 19.5 kg (size of one side: 420 x 310 mm) used by army for ponies was identified for refinement to maximize its use for enhancing pack load capacity of Yaks ensuring safety and comfort (Figure 4). The improved saddle (weight: 3.2 kg, tensile strength: 25 Newton/sq.mm, unit price: Rs 1000/-) was developed in collaboration with the GBPUAT Pantnagar centre of the Project. The saddle was used for Yak (Body weight: 400 kg, age: 4 years, sale price: Rs 18000/-). The improved saddle was made of composite material (resin, hardener, reinforcement element, silica, glass wool, jute net using moulding and casting technology to ensure strength and durability).

3. Results and Discussion

For Yak (Average body weight : 350 kg) traditional wooden saddles weighing 4.7 kg (unit price Rs 2000/-, tied with yak hair water proof rope) was tested for pack-load transport carrying average of 80 kg material and negotiating

60% slope for 3 km (Figure 5) at Derang in west Kamrang district of Arunachal Pradesh. The Yak (adult of 3 years age) could be able to transport material using traditional saddle for 25 km distance at average speed of 2.8 km/h in 09 hour. The physiological parameters before pack loading were measured for pulse rate: 66/min, respiration rate: 33/min and body temperature 40.38°C (104.7°F), at ambient temperature of 17 °C. After 1 km of travel on steep slope (60%) the pulse rate, respiration rate and body temperature were measured to be 90/min, 40/min and 40.5°C (104.9°F), respectively which were considered to be within the safe limit as mentioned in the Table 1. The physiological measurement taken and pack load at Derang Arunachal Pradesh have been shown in Figure 6 (Tiwari et al. 2012). The test trial of developed improved saddle was performed at Thangu region (Altitudes 4270 - 4800 m) in north Sikkim district during winter. The maximum pack load of 120 kg (three bags of potato each of 40 kg weight) on yak could be transported covering 5.5 km distance (travel speed : 2.62 km/h) in two hour duration at steep up slope of 60 degree. It showed that newly developed saddle was able to take 30% more load over traditional saddle. The physiological responses (respiration rate/min, pulse rate/min and body temperature in °C) were measured before and after the test trial. The result showed that respiration rate, pulse rate and body temperature were increased by 22%, 31% and 1.7% during two hours trial. Further when improved saddle on yak was used for carrying goods to longer distance (12 km at average up slope of 60 degree) only 80 kg of potato in two bags could be transported in 5.5 h (with 45 minutes rest in mid-way). The respiration rate, pulse rate and body temperature increased by 30%, 40% and 1.8% to cover 12 km distance at 4270 to 4800 m altitude and those were considered to be within the physiological limits of the yak. The Yak rearing farmer (having 130 yaks in group) after viewing improved saddle (Figure 7) informed that when traditional saddle was used it could last for 6 month only and using for transport of goods, it could fetch Rs 1.5 lakh profit annually per yak and it may fetch higher return by 25% if new composite material saddle is used.

Table 1. Pack load studies of Yak on steep slope using traditional saddle of Derang (West Kameng) in Arunachal Pradesh {Yak speed: 2.8 km/h, Ambient temperature 17°C}

Salient feature of Yak and saddle used	Before work			After work		
	R-R Breath/min	P-R Beat/min	Body Temp, ⁰ C	R-R Breath/min	P-P Beats/min	Body Temp, ⁰ C
Local black colour Yak (Age 3 years body, weight : 350 kg, pack load capacity : 80 kg on steep slope of 60 degree) Traditional wooden saddle tied with yak hair water proof rope (weight : 6.7 kg, unit price : Rs 2000)	33	66	40.38	40	90	40.5

Conclusion

- i. The local yak (weight :350 kg) using traditional saddle (weight : 6.7 kg) showed pack load capacity of 80 kg negotiating 60% slope for travelling 3 km in one hour duration in Arunachal Pradesh conditions.
- ii. The respiration rate, pulse rate of yak (weight : 350 kg, age: 3 years) increased 17% and 26% respectively for covering one km distance slope negotiating 60% in Arunachal Pradesh conditions.
- iii. The maximum pack load of 120 kg (three bags of potato each of 40 kg weight) on yak could be transported covering 5.5 km distance (travel speed : 2.62 km/h) by using composite material saddle in two hour duration at steep up slope of 60 degree at Lachen region in north Sikkim.

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