# Development and Evaluation of Improved Feeders for Goats Suitable to Stall-fed Management System

Chet R Upreti[1], Bahadur S Kuwar[2], Shambhu B Panday[3]

[1] Animal Nutrition Division-NARC, Khumaltar
[2] Agricultural Research Station (Goat)-NARC, Bandipur
[3] Nepal Agricultural Research Council, Singhadarbar-Kathmandu

**ABSTRACT**

Five different types of feeders were designed and tested on goats to find out their effectiveness in reducing feed wastage and cost fabrication. Experiment was conducted at Agriculture Research Station (ARS)-Bandipur for two years. Tested feeders were hexagonal, rectangular, hay rack, chain barrel and conventional wooden Tatnu. Feeders were fabricated using iron bars and woods. They were tested with the adult goats for feed wastage and feed contamination. Experimental feeds were fodders twigs (Tanki), forage (Stylo, Napier), crop residue (straw from black bean) and commercial concentrate. Chain barrel type of feeder was also tested at farmer's field at Baradi. Rectangular feeders have significantly lower ($P<0.01$) feed wastage (6.61% for fodders) compared to other tested feeders. The fabrication cost was NRs 3200, 1700, 700, 900, and 150 for hexagonal, rectangular; hay rack, chain barrel and conventional wooden Tatnu respectively. The rectangular feeder is suitable for goats feeding in Tarai and in the hills of Nepal. It has provision for feeding fodders, grasses, crop residues and concentrates together at the same time. Chain barrel type had comparatively higher wastage (10.7% for fodder) than the rectangular but was preferred by the farmers due to its low fabricating cost, portable in size, small space required and easy to handle. Therefore, the rectangular feeder is recommended for middle level farmers and chain barrel for small farmers who rear few goats.

**Key words:** Contamination, cost effective, feed saving, small farmer, stall-feed, suitable feeders

## INTRODUCTION

Goats are one of the most important livestock commodities in Nepalese rural farming system. They are the main economic sources in the rural farming communities. The main purpose of goat keeping is for household income, manure, meat and pack use. Although the goats are fed on locally available feed resources, the cost of production is still high. High cost is due to unscientific conventional feeding practices adopted by the farmers in the rural area. Contamination of feeds with feces, urine and stamping is commonly found in conventional feeding practices that normally causes considerable wastage of offered feeds. Goats naturally prefer to eat at the height of about 20 to 120 cm above the ground (Peacock 1996). They can stand on their hind legs for long period. Goats find it difficult to eat directly off the ground. As goats are selective feeders by natural habit, they do not eat once the feed is dropped on the ground and stamped (Peacock 1996). This problem can be solved if suitable low cost feeder could be fabricated and used for goats feeding. Feeders can be fabricated using different materials such as metal, bamboo and wood but it is important to use the cheaper and durable materials. Feeders should be portable which can be easily transported in mountain terrain. Therefore this work was done to develop the suitable feeders for goats feeding under the stall feed management system.

## MATERIALS AND METHODS

### Feeder fabrication

Five different types of feeders namely hexagonal, rectangular, hay rack, chain barrel and traditional Tatnu were designed and fabricated using iron bars, GI sheets, galvanized mesh for improved feeders, and wood and bamboo for Tatnu. These feeders were fabricated as adopted by Mishra et al (1992) and Singh et al 1992). Some of these feeders were further fabricated using wood to reduce the cost. Following were the dimension and procedure for fabricating different feeders. Experiment was conducted at ARS-Bandipur during 1999-2001.

### Hexagonal feeder

Hexagonal feeders consisted of 6 legged stand on which a hexagonal bottom trough was fitted with a six faced central hexagonal – shaped pyramid rack mounted with iron bar over the table. The lower portion of the rack had vertical slanting iron bars outwards. The feet paddles were fixed at 37 cm height from the ground to prevent stamping on feeding trough, as goats prefer to eat raising two front legs. The height of the feeding trough was based upon the average wither height of the goat. The depth and width of the feeding trough were 10 cm and 15 cm, respectively. Feeder had a 4 legged iron stand, a GI rectangular feeding trough with a triangular pyramid in the middle and a vertical and slopping hay rack mounted on the feeding trough as shown in Figure 1. The upper portion (20 cm) of the rack was covered with GI sheet and lower portion consisted of iron bars at 7 cm interval. It has provision of feeding concentrate, green fodder (ground forage and fodder twigs) and dry roughage simultaneously. The rack portion was used for dry roughage and green fodder and the feeding trough for the concentrate (Figure 1). The dimension of hexagonal feeder is presented in Table 1.

### Rectangular feeder

Rectangular feeder had 4 legs iron stands, a rectangular shaped feeding trough of GI sheet, a triangular pyramid in the middle and vertical and slopping hay rack mounted on the feeding trough. The upper portion (20 cm) of the rack was covered with GI sheet and lower portion consisted of iron bars. The height of the feeding trough and the distance between the 2 iron bars (7 cm) of rack were based on the various dimension of the mouth/ jaw of the goats. The feeder has provision of feeding concentrates, green fodder (forage and fodder twigs) and dry roughages. Provision for drinking water could be made by hanging a water bucket at both sides, which could be anchored with feeder by a circular iron ring. The rack portion was used for dry roughage and green forage and the feeding trough for the concentrate (Figure 2). The dimension of the rectangular feeder is presented in Table 1. The height of the feeding trough could be changed by digging the feeders in the floor to adjust the optimum height for large and medium size breeds of goats.

**Table 1. Dimension and measurements of different types of feeders**

| Measurement | Hexagonal | Rectangular | Hay rack | Chain barrel | Conventional Tatnu |
|---|---|---|---|---|---|
| Total length, cm | 150 | 150 | 145 | 130 | 145 |
| Height up to hopper, cm | 55 | 47 | 52 | 48 | 74 |
| Height up to top of the hopper, cm | 87 | 87 | 89 | 90 | 70 |
| Width of feeding trough, cm | 15 | 15 | - | - | - |
| Depth of feeding trough, cm | 10 | 10 | - | 90 | 70 |
| Circumference, cm | 378 | 302 | - | 245 | - |

### Hay rack

Hay rack was developed using 4 legged angle iron structures. A vertical and slopping hay rack was mounted on the table. Flat GI sheet replaced the pyramids of Hexagonal feeders. This feeder was

designed for dry rough and green fodder (Figure 3). The height of the feeder table (height of the stand) was related to wither height of goats.

**Chain barrel feeder**

Chain barrel type of feeder was fabricated from galvanized wire mesh and iron rods. Feeder had 4 legged circular feeder having two circular iron rings joined with legs at the bottom and with iron rods at the top. The circumference of lower circular iron ring was 215 cm on top of which a galvanized wire mesh with iron rods was vertically attached. The circumference of feeder at the top was 245 cm. The vertical rod and circular ring at the top were attached with the lower ring and legs. Inside this dome shaped feeder four iron bars of 48 cm were attached in slanting position with bottom ring in lower side and with an iron ring of 15 cm circumference at the top. The galvanized wire mesh also covered the inside rods. The height of legs from ground was 48 cm. This type of feeder has provision for feeding fodder, green grasses and crop residue but has no provision for feeding concentrate (Figure 4).

**Conventional Tatnu**

This type of feeder is being used in rural area of Nepal. Y – shaped tree branches were used to make the feeder. Wooden pole was used to hold the fodder. The bases of the U- part of the Y shape was at 57 cm ie of shoulder point height of the goats (Figure 5a, 5b). Feeder was fixed at open plain ground in 10- × 10-m enclosure.

**Feeder testing**

Fabricated feeders were tested using 6 adult Khari and 50% Crossbred (Khari × Jamunapari) goats of similar age, weight and body condition score (3 - 4) to each feeder. Observations were made to compare different types of feeders in respect to feed wastage and contamination of concentrates, straw, green fodder and fodder twigs with the use of hexagonal, rectangular, hay rack, chain barrel and conventional Tatnu. Different parts of feeder were adjusted to make comfort to the goats. The animal were fed with concentrate @ 1% body weight in the morning 7 am, and then grasses (stylo) after 2 hours and again after 2 hours fodders twigs were offered. Feed wastage in each type of feeder for feed/ forage was recorded at the end of each feeding. The percentage of wastage was determined as below:

$$\% \text{ feed wastage} = \frac{(\text{Amount of feed wasted})}{(\text{Amount of feed offered})} \times 100$$

This feeder testing experiment was carried out for 15 days after 7 days of adjustment period for each feed type. After analysis of variance means were compared using LSD.

## RESULTS AND DISCUSSION

The highest floor space required was found in rectangular feeder, followed by hexagonal, hay rack, and chain barrel (Table 2).

**Table 2. Floor space occupied by different types of feeders**

| Type of feeder | Length, cm | Breadth, cm | Area, $m^2$ |
|---|---|---|---|
| Hexagonal | 120.0 | 120.0 | 1.44 |
| Rectangular | 150.0 | 150.0 | 2.25 |
| Hay Rack | 140.0 | 75.0 | 1.05 |
| Chain Basket | 90.0 | 90.0 | 0.81 |
| Conventional Tatno | 135.0 | - | - |

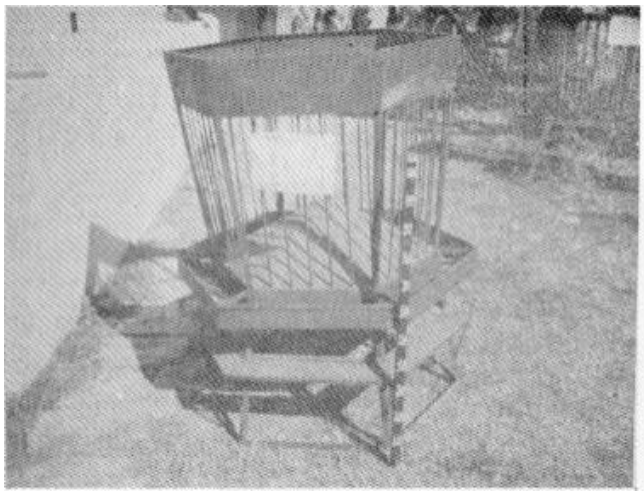

**Figure 1. Hexagonal Feeder**

**Figure 2. Rectangular Feeder**

**Figure 3. Hay Rack Feeder**

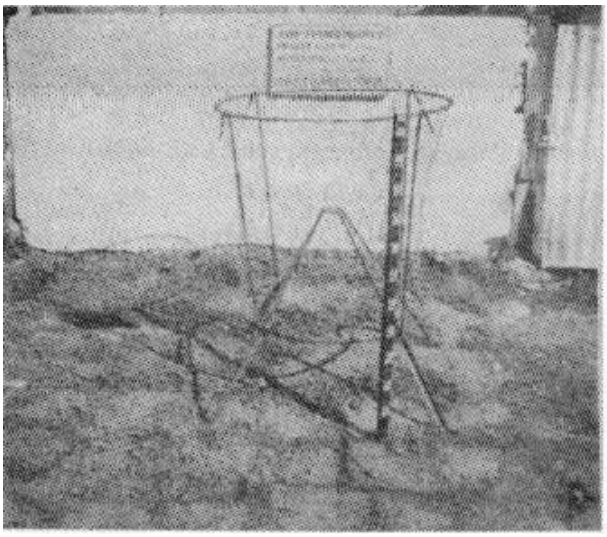

**Figure 4. Chain Barrel Feeder**

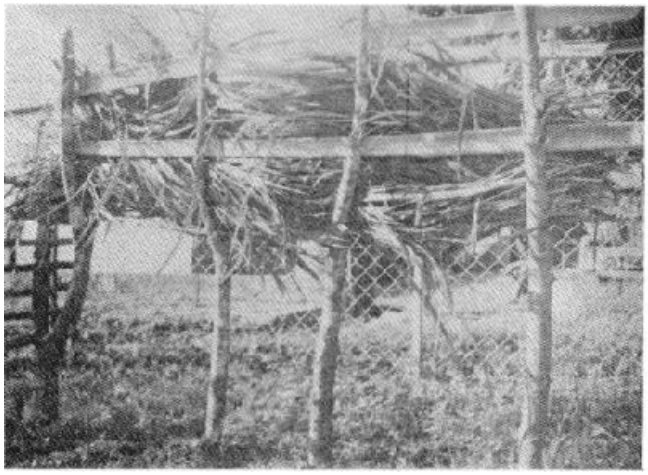

**Figure 5a. Conventional Tatnu Feeder**

**Figure 5b. Traditional feeding system**

**Wastage of feed**

The mean feed wastage of different types of feeders is given in Table 3. The wastage of concentrate is lower in rectangular feeder (0.61%) compared to hexagonal feeder (2.53%). For the hay rack, chain barrel and conventional Tatnu there was no provision for feeding concentrates therefore, a separate round feeder was used to feed concentrate in which maximum wastage of 4.30% was found. This wastage of concentrates in hexagonal and rectangular feeder were comparatively lower than reported by Mishra et al (1992) which were 1.43% and 2.03% respectively.

**Table 3. Feed wastage in different types of feeders (mean of 6 adult goats)**

| Feed type | Feed utilization | Hexagonal | Rectangular | Hay Rack | Chain Barrel | Conventional Tatnu |
|---|---|---|---|---|---|---|
| Concentrate | Offered, g/d | 350.0 | 316.0 | 0.0 | 0.0 | 0.0 |
| (HC feed) | Refused, g/d | 8.88 ± 1.9 | 1.94 ±1.2 | 0.0 | 0.0 | 0.0 |
| | Wastage, % | 2.53[a] | 0.61[b] | 0.0 | 0.0 | 0.0 |
| Green forage (stylo) | Offered, g/d | 250 | 250 | 250 | 250 | 250 |
| | Refused, g/d | 51.24 ± 10.5 | 19.37 ±11.74 | 74.79 ± 25 | 43.25 ± 2.3 | 84.16 |
| | Wastage, % | 20.49a | 7.74b | 29.61c | 17.3d | 33.66e |
| Straw | Offered, g/d | 250.0 | 250.0 | 250.0 | 250.0 | 250.0 |
| (Black bean) | Refused, g/d | 38.12a ± 26.02 | 26.24b ± 18.89 | 64.58c ± 36.55 | 40d ± 4.2 | 119.99e ± 55.83 |
| | Wastage, % | 15.24 | 10.49 | 25.83 | 16.0 | 47.99 |
| Green Forage | Offered, g/d | 2500.0 | 2500.0 | 2500.0 | 2500.0 | 2500.0 |
| (Napier) | Refused, g/d | 687.49 ± 62 | 346.66 ± 176 | 416.66 ± 68 | 487.5 ± 65 | 723.74 ±62.54 |
| | Wastage, % | 27.49 | 13.86 | 16.66 | 19.5 | 28.94 |
| Fodder (Tanki) | Offered, g/d | 2500.0 | 2500.0 | 2500.0 | 2500.0 | 2500.0 |
| | Refused, g/d | 532.91 ± 21 | 165.41 ± 56 | 201.66 ± 93 | 268.2 ± 25 | 458.74 ± 38 |
| | Wastage, % | 21.31a | 6.61b | 8.06b | 10.73bc | 18.34ad |

*Means within a row followed by common letter/s do not differ significantly at the 0.05 probability level.*
*HC Hetaunda cattle feed.*

Wastage of green forage (stylo) was substantially low (7.74%) in rectangular feeder compared to hexagonal (20.49%), hay rack (29.91), chain barrel (17.3%) and conventional Tatnu (33.66%). The rectangular feeder had lowest losses of straw (10.49%), Napier (13.86%) and fodder (6.61%) compared to other feeder types (Table 3). The main reason for the comparatively higher feed losses in hexagonal feeder compared to rectangular was due to the loose pieces of green fodder coming out of the rack portion while animals pull the green fodder. These findings of concentrate, fodder and grass in hexagonal feeder are contrary to the Indian studies (Singh et al 1992) however in agreement for wastage of straw. Straw feed wastage in hexagonal feeder was reported to be 15% (Singh et al 1992), which was similar in this study. Straw wastage in rectangular feeder was also higher (10.9%) in this experiment compared to the wastage (8.84%) reported by Mishra et al (1992), which could be due to use of chaffed straw (8 cm long) in the present trial.

**Feed contamination**

The contamination of concentrate, green forage, straw and fodder twigs with faeces and urine was almost totally prevented with the use of hexagonal and rectangular feeders. Similarly contamination of green forages, straw and fodder twigs were prevented in chain barrel and hay racks. In hexagonal, rectangular, chain barrel and hay rack, the animals were not able to void faeces or urine in the feeding trough and animals were not able to enter in the feeding trough. However in feeder without the provision for concentrate feeding, concentrate was supplemented in a separate wooden round feeder on

ground near by the rack. Concentrate feed in the wooden round feeder was stepped by the goats and got contaminated with faeces and urine.

**Forage cost saved by different feeders**

The feeder that involves lowest feed wastage and lowest cost of wastage feed was considered economic feeder (Singh et al 1992). Here, in the rectangular feeder there was lowest feed wasted and the cost of wastage feed was lowest (Rs 10.38) therefore it was the best and highest economic feeder among others (Table 4). This was followed by hay rack (Rs 14.08) and chain barrel (Rs 15.82). By looking feed wastage to all different feeds in different feeders, rectangular feeder was found more suitable for simultaneous feeding of all types of feeds and could be used in hills and Tarai of Nepal. Though hay rack ranked second in the saving of feed wastage, chain barrel type is more accepted by the farmers as it is portable and take smaller space in the shed.

**Table 4. Cost of wasted feed in each feeder (six adult goats/ feeder)**

| Feeder | Fodder tree | | | Napier | | | Stylo | | | Black gram straw | | | Total cost, Rs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Waste, kg | Rate, Rs/kg | Cost, Rs | Waste, kg | Rate, Rs/kg | Cost, Rs | Waste, kg | Rate, Rs/kg | Cost, RS | Waste, kg | Rate, Rs/kg | Cost, Rs | |
| Hexagonal | 3.19 | 3.50 | 11.16 | 4.12 | 3.0 | 12.37 | 0.3 | 3.5 | 1.05 | 0.23 | 2.0 | 0.46 | 25.04 |
| Rectangular | 0.99 | 3.50 | 3.44 | 2.08 | 3.0 | 6.24 | 0.11 | 3.5 | 0.38 | 0.16 | 2.0 | 0.32 | 10.38 |
| Hay rack | 1.21 | 3.50 | 4.23 | 2.5 | 3.0 | 7.5 | 0.45 | 3.5 | 1.57 | 0.39 | 2.0 | 0.78 | 14.08 |
| Chain barrel | 1.61 | 3.50 | 5.63 | 2.9 | 3.0 | 8.8 | 0.26 | 3.5 | 0.91 | 0.24 | 2.0 | 0.48 | 15.2 |
| Tatnu | 2.75 | 3.50 | 9.63 | 4.34 | 3.0 | 13.02 | 0.50 | 3.5 | 1.75 | 0.72 | 2.0 | 1.44 | 25.84 |

*For the calculation of cost, price of concentrate was considered Rs 12/kg, Stylo, Rs 3.5/kg, Black bean straw Rs 2/kg, Napier Rs 3/kg and fodder Rs 3.5/kg.*

Different types of feeders were developed and compared for the amount of feed wastage and contamination. The finding indicated that the rectangular type of feeder was better in feed saving, economic and low in feed contamination compared to other types. This type of feeder was found more suitable for simultaneous feeding of all types of feedstuff and could be used to feed goats managed under stall-fed condition in the Hills and Tarai of Nepal. Due to the lower space required in the shed and portable in size, small farmers at outreach site preferred chain barrel type of feeder. Chain barrel type is suitable for small farmers as it is handy and cheaper.

Rectangular feeder in which tree leaves, grasses, concentrates and crop residues could be fed simultaneously, has lowest feed wastage and contamination, and hence is suitable for feeding goats in the Hills and Tarai under stall-fed management system. However, chain barrel type of feeder in which tree leaves, grasses and crop residue could be fed, is suitable for small farmers. Fabricated dimension of these feeders are suitable to feed 6 adult goats with their followers.

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