

## Genetic gain in selected herds of Khari goats over generations in Nepal

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### Background

There are 6.8 million goats in Nepal and these goats produce about 40 thousands MT meat, which comprises 19.5 % of the total meat production in the country (Statistical Information on Agriculture, 2004). Meat production and consumption from goats' ranks second to that of buffaloes in the country. Goats are very important livestock species in the eastern hills of Nepal. Eighty five per cent of the farming households own goats in the Koshi hill districts (part of the eastern hills) where they are reared mainly for meat (Gurung *et al.*, 1989). They also rank second to buffaloes as a source of income generation (Gatenby *et al.*, 1990<sup>a</sup>). They are owned by almost all the categories of the people (including ethnic groups and poor and subsistence farmers). They are also kept by women as a *Pewa*, (*where women particularly keep animals, take care of the animals and use the money coming from sale of the animals*). The price of goat meat has increased by almost 300 % over the last ten years (Kharel and Pradhan, 1988).

There are four indigenous goat breeds, namely Terai, Khari, Sinhal and Chyangra. Khari (or Hill goat) is the main goat breed in the country and represents 56 % of the goat population. Exotic and crossbred goats in the country are few (10%) (Animal Genetic Resources of Nepal, 2004).

The Khari goats, located in the hills are prolific and well suited to the local environment. However, when compared to the Indian breeds (Jamnapari, Barbari and Beetal) which were introduced in the early 1970s through Pakhribas Agricultural Centre (PAC) and Koshi Hill Development Programme (KHDP) for crossbreeding, they have lower weaning weights and a lower mature size. It was anticipated that the crossbreeding of local Hill goats with larger Indian breeds would improve these traits and increase overall productivity (total meat output per doe per year). The requirements for breed improvement were identified as kid growth, greater mature size, and improved milk yield (Neopane, 1997).

An evaluation of Indian-Hill crossbred goats on farms in the mid 1980s indicated that these goats were not adapted to local environments of limited feeds, disease problems and management (Oli, 1987). The crossbreds had higher mortality from diseases. The overall productivity of crossbreds (in terms of meat output per doe per year) was also lower than that of local goats. Khari goats produced 60% more meat than crossbreds. Pradhan and Gurung (1985) reported that the local Hill goat was better than Jamunapari and its crossbreds in terms of reproductive performance. From the study, it was suggested that selection within the local breeds would be a better option for genetic improvement. The main trait of interest in the indigenous goats was its greater reproductive rate (higher litter

size and shorter kidding interval). However, the lack of adequate milk and low mature body size in local goats would cause a lower weaning rate and weight. Increased weaning rates could be achieved either by increasing litter size or reducing kidding intervals (Gatenby *et al.*, 1990<sup>b</sup>).

A within breed selection programme started in 1987. A flock of pure- bred indigenous goats was established at PAC by purchasing local goats from different villages of the eastern hills (Dhankuta, Terhathum, Sankhuwasabha, Bhojpur, Taplejing, Panchthar, and Ilam districts). Over time, this expanded to a flock comprising 120 breeding female goats. Records on pedigrees, growth and reproductive performances have been maintained continually.

### Genetic parameters of production traits

Heritability estimates for body weights of Hill goats are moderate to high (obtained using REML) ranging from 0.22 for 36 weeks to 0.53 for birth weight (table 1). Moderate to high estimates of heritability indicated that the additive genetic variation exists and that selection should be effective for improving these traits relatively quickly. Heritability estimates for litter size are low but the estimates for litter weights are moderate suggesting that selection may be effective for improving these traits.

**Table 1: Heritability estimates of production traits of Hill goats.**

Traits	Heritability (Harvey)	Heritability (REML)
Birth weight	0.32±0.098	0.53±0.054
Weaning weight	0.08±0.067	0.35±0.064
6 month weight	0.14±0.141	0.36±0.089
48 week weight	0.19±0.120	0.33±0.093
Litter size at birth	0.10±0.093	0.03±0.050
Litter size at weaning	0.05±0.097	0.03±0.083
Litter weight at birth	0.44±0.155	0.21±0.232
Litter weight at weaning	0.66±0.202	0.16±0.120
Kidding interval	0.03±0.099	0.03±0.039
Gestation length	0.21±0.118	0.03±0.003

Source: Neopane (2000)

Strong genetic and phenotypic correlations existed amongst the post weaning weight traits (6 month, 36 weeks and 48 weeks) (Table 2). This indicates that 6 month weight can be a good selection criterion for improving finish weight of Hill goats at later ages.

**Table 2: Genetic and phenotypic correlations amongst body weights in Hill goats**

	Birth weight	Wean weight	6 month weight	48 week weight
<b>Birth weight</b>		0.59 ± 0.237	0.85 ± 0.195	0.02 ± 0.328
<b>Wean weight</b>	0.43		0.87 ± 0.125	0.74 ± 0.224
<b>6 month weight</b>	0.51	0.83		0.84 ± 0.188
<b>48 week weight</b>	0.27	0.65	0.74	

Source: Neopane (2000); Genetic correlations above and phenotypic correlations below diagonal

### Selection process

Based on the results of a study by Neopane (1997), an appropriate selection programme using a simple index, was developed. The criteria for selection were weaning weight of the kids, number of kids born per kidding and six month weight for both sire and dam lines. The anticipated genetic gain for both weights and reproductive traits (litter weights) is presented in Table 3, and was anticipated to be substantial if the animals were selected on the basis of criteria developed.

**Table 3: Predicted response to selection for both growth and reproductive traits**

Traits	Genetic gain/year (a)	R	Genetic gain/year (b)	R
Birth weight (g)	105	6.4	58	3.5
Weaned weight (g)	289	4.0	159	2.2
6 month weight (g)	276	3.4	152	1.9
36 weeks weight (g)	295	2.9	162	1.6
48 week weight (g)	394	3.2	216	1.8
LS at birth (no)	0.008	0.5	0.005	0.3
LS at weaning (no)	0.008	0.6	0.004	0.3
LW at birth (g)	120	4.6	66	2.5
LW at weaning (g)	247	2.5	136	1.4

(a) When both selected bucks and does are used

(b) When only selected bucks are used

R = Response to selection per year (%)

Source: Neopane (1999)

**Characteristics of the nucleus flock:** Pakhribas Agricultural Centre (PAC) located in the eastern hills of Nepal has served as a nucleus flock for Khari/Hill goats. At the nucleus flocks there were 120 dams (20 dams in each parity from parity 1 to 6) and 15 bucks. 100% bucks were replaced every two years, and 20 dams (parity > 6) replaced annually. 15 males were selected out of 100 kids and they remained at the flock until 2 years producing offspring up to 29 months. 25 female kids were selected out of 100 kids and they were retained up to their sixth parity.

## **Dissemination Schemes**

Using selection in an open nucleus breeding scheme, productivity of the local hill goats at the PAC and in farmer's flocks could be increased. This was the first kind of work in Nepal in any species of livestock. The project involved two major components, the selection of better animals (firstly at the Centre but later both at the Centre and at the farmers flock) and dissemination of improved genes/animals to the local population. A total of 1228 animals from 181 households at five different sites from three eastern hill districts (Dhankuta, Terathum and Bhojpur) at two altitude levels (low: up to 1100 masl, and mid: 1100 to 1700 masl) were included at farm level in the project. The project was implemented with support of HARP (DFID) funding during 1998/1999 for three years both at the nucleus and farmer's flocks.

Selection of better bucks and dams was undertaken both at the nucleus flocks and among farmer's; flock based on identified selection criteria. Those having higher weights were selected and those having lower weights were culled from the flock. In the first year, the direction of gene flow was from the nucleus to the farmers. From the second year onwards, farmer's goats were evaluated and the better animals were selected. Bucks from the villages that performed better than the nucleus bucks were brought to the nucleus.

## **Monitoring of genetic gain**

During the project period, 197 kids were born at Belahara, 181 at Danda Bazar, 302 at Fakchamara, 157 at Muga and 160 at Hasanpur site from selected bucks. Among the 997 kids born, the number of multiple births was 546 whereas those born as single kids were 451. The sex ratio of kids was 523:474 for male and female. Usually, by nature single born kids are heavier than those born multiple. Average birth, four and six month body weights of single born kids at the sites were  $1.89 \pm 0.019$ ,  $9.59 \pm 0.156$  and  $11.9 \pm 0.214$  kg respectively whereas for multiple born kids these figures were  $1.67 \pm 0.016$ ,  $8.50 \pm 0.145$  and  $10.7 \pm 0.239$  kg respectively. The highest weight gain at the age of birth and four months was recorded at Belahara whereas that for six-month weight was at the Hasanpur site. Both these sites are situated at a low-hill region. In the low-hill regions (Belahara, Hasanpur, Muga), a free grazing system was the predominant management practice and it appears to have had a more favourable impact on better growth of kids than the partial grazing system practised in the mid-hill (Danda Bazar, Fakchamara) of the eastern Nepal.

The overall mean birth, 4 and 6 month body weights of offspring at the sites are presented in Table 4. Maximum body weight at birth, 4 and 6 months was 3.0, 18.0 and 18.5 kg respectively, whereas the minimum weight for the same age groups was 0.7, 4.0 and 5.7 kg respectively.

**Table 4: On-station (OS) and on-farm (OF) body weights of kids (Kg)**

Traits	Parental mean (OS)		Offspring mean (OS)		Parental mean (OF)		Offspring mean (OF)	
	Mean	N	Mean	N	Mean	N	Mean	N
Birth weight	1.65	1246	1.65	272	1.76	53	1.77	997
Weaning weight	7.61	885	7.61	154	7.63	117	9.11	418
6 month weight	8.76	567	8.76	123	9.43	155	11.36	232
9 month weight	11.55	569	11.55	536	-	-	-	-
12 month weight	14.31	519	14.31	453	-	-	-	-

Source: Pokharel *et al.* (2001); Pokharel and Neopane (2002)

Analysis of the result of first generation kids showed that the actual response to selection on station for 4 months weights, 6 months weight, 36 weeks weight and 48 weeks weight were 2.3, 2.9, 3.3 and 4.4 per cent per generation respectively. The genetic gain per year for these traits was 0.8, 1.1, 1.2 and 2.0 percent respectively (generation interval was 2.75 years). Predicted response was close to the observed and results obtained so far both in terms of reproduction and production were highly impressive.

Similarly, the response to selection per generation at On-farms (farmer's flocks) was 6.8 and 7.4 percent for 4 months weight and 6 months weight. The response to selection per year was 1.5 and 1.54 for these traits (generation interval was 4.5 years).

Although litter size is a trait with low heritability ( $0.03 \pm 0.050$ ) (Neopane, 1997) and genetic gain for this trait would be slow, results from the selection programme in the first generation has indicated some improvement in the number of multiple born kids (Table 5).

**Table 5: Type of birth at Station before and after selection**

Birth type	Parent	Offspring
Single	416 (32.0 %)	85 (31.3 %)
Multiple	885 (68.0 %)	187 (68.7 %)
Total	1301 (100 %)	272 (100 %)

### **Farmer's reaction to the selection programme**

- The farmers reported that the productivity of indigenous goat (Khari breed) has been increased through selection. The improvement could be further increased by applying good management practices.
- Initially farmers would castrate better kids (higher body weights) and keep poor ones for breeding, however, through the programme, the importance of using quality bucks for mating their does and avoiding negative selection for better goat production was understood.
- Use of bucks from the nucleus flock was adopted
- Improved management practices were also adopted.
- Other traits of interest such as coat colour and horn type were identified by the farmers. It was pointed out that butchers pay more money for straight horns.

### **Concluding remarks**

Khari goats are promising breeds mainly due to their prolificacy. Twinning and triplets are quite common, quadruplets are also sometimes found. Triplets and quadruplets gave difficulty in surviving due to dam's low milk yield. Weaning weight is a function of birth weight and maternal ability (milk and mother instinct) and milk yield appears to be an important trait. The results showed that selection within Khari breed was very effective in bringing genetic improvement in weights traits particularly. Following the success of the selection programme, the Department of Livestock Services (DLS) has been implementing selection among the Hill goats across the hills of country. Crossbreeding Hill goats with Jamunapari goats has stopped. Non-governmental Organizations (local and international) have been encouraging Hill goats. At the moment, there is a lot of pressure at the nucleus flock for bucks as artificial insemination has not been in practice in goats.

### **Question for discussion**

Goats are seasonal breeders and majority of them come into heat twice a year. However, distributed bucks were not adequate to provide service. What alternative dissemination methods could be used?

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