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Preliminary results from reseeding degraded Dera Ghazi Khan rangeland to improve small ruminant production in Pakistan

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Abstract

Thatta Leghari rangeland in the Dera Ghazi Khan district of Pakistan covers an area of 1004 ha. Its topography is undulating, soil is calcareous and low in organic matter and supports a native standing crop of mainly unpalatable herbaceous vegetation. Due to uncontrolled grazing the range has degraded from its productive potential. Between 1992 and 1993 the native range (1004 ha) was not grazed. Then in 1992 and 1993, a 600 ha area was reseeded with two introduced grasses, Gorkha (*Lasiurus sindicus*) and Buffel grass (*Cenchrus ciliaris*). Forage production on both the reseeded and native range was measured in 1992 and 1993 at the end of the growing season during October. Weather during these 2 years reflected the long term mean conditions with respect to temperature and distribution of precipitation. The reseeded area produced 10 times (4000 kg/ha) more forage than the native range (425 kg/ha) in 1992 and more than twice the forage (1250 kg/ha vs 534 kg/ha) in 1993, a year with 37 mm less total rainfall. Proximate analysis of the forage harvested in 1993 was determined for both treatments. Buffel grass was higher in crude protein (7.8%) than Gorkha (6.2%) and chimber (5.9%; *Eleusine flagellifera*) a native grass. The native shrub, lana (*Salsola foetida*) had a higher energy value, 2.7 Mcal/kg, than all of the other species. Daily goat and sheep diets consisted of 51% and 32% shrub, respectively, with grasses comprising the remainder. Forbs composed 35% of the sheep diet whereas, shrubs (51%) dominated the goat diets on the reseeded rangeland. Liveweight gain differed ($p<0.05$) between goats (34 g/day) and sheep (14 g/day). These preliminary results indicate that reseeding may be an important intervention for Pakistan rangeland improvement, for improving nutrition for small ruminants.

Keywords: Pakistan; Rangeland; Forage species; Reseeding; Sheep and goat; Behavior

1. Introduction

Rangeland reseeding has been recommended as a possible management practice to improve forage production when coupled with proper stocking, provided natural conditions favour both seed germination and seedling establishment. When rangeland vegetation consists of unpalatable plants coupled with low forage production, reseeding may be a viable range remediation practice in Pakistan (Mohammad, 1984). This is especially important since Pakistan animal production

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relies almost entirely on range fed livestock. Small ruminants in Pakistan receive more than 60% of their feed requirements from arid and semi-arid rangelands (Qazi et al., 1988; Khan et al., 1990). Gorkha (*Lasiurus sindicus*) a warm season grass has been successfully reseeded in Thall, Cholistan and Kohistan ranges in Pakistan (Mohammad, 1984). Buffel (*Cenchrus ciliaris*) another warm season grass is extremely drought resistant and has been recommended for reseeding arid and semi-arid Pakistan rangelands (Mohammad and Naqvi, 1987; Butt et al., 1990). Fifty-fifty mixtures of Buffel and Gorkha have successfully been seeded at a rate of 6 kg/ha and established in rows 75 cm apart on denuded silt flats near Rajastan (Mohammad, 1984). The objectives of this study were to increase available grass and subsequent livestock production through reseeding native range with Gorkha and Buffel and by controlling the subsequent farming of sheep and goats.

2. Study area

Rangelands of Dera Ghazi Khan (D.G. Khan) are located between latitude 28° to 31° south and longitude 69° to 70° east with the Sulaiman mountains to the west and the Indus River on the east. The area covers 2638 ha and has 12 rakhs or range sites (Mohammad, 1984). One rakh, the Thatta Leghari was chosen for this study because of its severe degraded condition as reputed by Mohammad (1984). It has an area of 1004 ha and lies 90 km north of Dera Ghazi Khan and 20 km north of Taunsa, a city of 200,000 population. The topography of the area is undulating with deep, well drained, calcareous, medium-textured soils that are low in organic matter (Mohammad, 1984).

The climate is typical of very arid submountainous, sub-tropical continental areas, characterized by cold winters and very hot summers. Mean ambient winter temperatures occasionally drop to 0°C in January and February while mean maximum ambient temperatures in June and July reach 42°C (Mohammad, 1984). Mean annual precipitation varies from 75 to 162 mm, with most occurring during the months of July and August, the monsoon season (Alizai and Habib, 1987).

Rangelands in D.G. Khan have degraded over the last several decades due to excessive grazing and overstocking by nomadic and local livestock coupled with improper and excessive harvesting of shrubs for fuel and fodder purposes. Farming and raising livestock particularly sheep and goats, are important income sources in D.G. Khan. Women play a major role in livestock production. They are responsible for crop harvesting, herding and feeding of animals (Khan, personal communication). More than 70% of the area is bare ground and extremely vulnerable to water and wind erosion. Many of the palatable forage species have been replaced by unpalatable species.

3. Material and methods

The study was initiated in May 1992 on 1004 ha of D.G. Khan rangeland in collaboration with the Punjab Forest Department. In June a vegetation survey was conducted on the 1004 ha to determine existing species. Following the survey two similar areas, each 300 ha, were chosen, one area was reseeded at a rate of 6 kg/ha with a mixture of Buffle and Gorkha in a 9:1 ratio, respectively, during July 1992. The adjacent and similar 300 ha was planted during July 1993 using a mixture (massbasis) of Buffle and Gorkha in a ratio of 1:9, respectively. Prior to planting, the area was disc plowed three times to prepare a seadbed and remove unwanted shrubby and herbaceous vegetation. The mixtures of Buffel and Gorkha varied between years due to available seed. Seeds were broadcast manually followed immediately by dragging large pieces of brush behind a tractor to cover the seed. Domestic animals grazing was excluded for the remainder of the year in which seeding took place to allow for seedling establishment. Guards were used to exclude animals from the reseeded area. Forage production and species composition data on both native and reseeded range were recorded using line transect sampling during October 1992 and October 1993. There were two livestock water wells in each of the two 300 ha reseeded areas. A point was randomly selected near each water point. Using a compass, an imaginary line was established from this point in each of the four cardinal directions. Along each of the four lines radiating out from the two points, 10 randomly located 1.0 m^2 square plots, each separated by 100 m, were

placed and vegetation was sampled. Plots were established by throwing a square metal frame to the right side of each of the ten randomly selected points along each of the four lines. All plants within the 1.0 m^2 quadrate were recorded by species and then clipped leaving a 15 cm stubble height. Clipping was done in October 1992 and 1993. Air dried forage production (g/m^2) and chemical composition of intact plants were determined according to AOAC, (1985) procedures. Regression equations (Ahmad and Muller, 1986) were used to predict energy values of the different plant species. Precipitation data for 1991, 1992 and 1993 were recorded in a single rain gauge located about 5 km from the reseeded area.

Twenty mature nonpregnant ewes of the Damani sheep and 10 female goats of the Nachi breed were used to graze on the seeded and native range sites. The 30 small ruminants were randomly moved between the seeded and native range sites between February and December, 1993. A herder was used to configure the livestock within each area. Individual shrunk liveweight data were recorded initially and then every 30 days following on overnight fast off both feed and water. Grazing behaviour was monitored between November and December 1993. Behavior data were recorded by two observers. One observed goats and other observed the sheep. All activities as it included: grazing, standing and lying were recorded every 5 min. Ten randomly selected sheep and all the 10 goats were each observed throughout a period of 5 consecutive days between 07:00 and 12:00 hours and again between 15:00 and 18:00 hours. The 10 animals within each species were observed in a non-random order as the observer moved among the animals. The first animal was chosen for 5 min, thereafter, the next animal observed which was the closest to the observer. The procedures were followed until all 10 animals had been observed within species. No sheep and goats were lost or died during the study period. The liveweight change data were analyzed with the *T*-test (Steel and Torrie, 1980). Significant difference were separated using the least significant difference method (Steel and Torrie, 1980). The behaviour data were analyzed with analysis of variance using the GLM procedures of the statistical analysis system (SAS, 1982).

4. Results and discussion

4.1. Forages species, production and precipitation

Vegetation present in the rakh were recorded by species and presented in (Table 1). Only less palatable species were encountered on the native range. Chimber (*Eleusine flagellifera*) was the dominant grass and lana (*Salsola foetida*) was the dominant shrub. Together these two species comprised over 80% of the vegetation. The remaining 20% of the plants were sehnwar (*Rhazya stricta*), bui (*Aerva javanica*), phog (*Calligonum polygonoides*), kikri (*Acacia jacquemontii*), karir (*Capparis decidua*), khip (*Leptadenia spar-*

Table 1
Mean air dry standing crop (kg/ha) and frequency (%) with which species were encountered in October 1992 and 1993 from native and reseeded Thatta Leghari rangeland in Pakistan

Species		1992				1993			
		Reseeded		Native		Reseeded		Native	
		DM (kg/ha)	Frequency (%)	DM (kg/ha)	Frequency (%)	DM (kg/ha)	Frequency (%)	DM (kg/ha)	Frequency (%)
Buffle (*Cenchrus cliaris*)	G	1130	25	–	–	290	23	–	–
Gorkha (*Lasiurus sindicus*)	G	1250	35	–	–	225	18	–	–
Chimber (*Eleusine flagellifera*)	G	720	10	278	60	198	18	280	54
Lana (*Salsola foetida*)	S	800	30	109	20	538	41	235	30
Phog (*Calligonum olygonoides*)	S	–	–	20	10	–	–	10	8
Bui (*Aerva javancica*)	F	–	–	18	10	–	–	9	8
Total		3900	100	425	100	1251	100	534	100

G: Grass, F: Forb, S: Shrub.

tium), jand (*Prosopis cineraria*), mallah (*Zizyphus nummulria*) and ak (*Calotropis procera*) with phog and bui comprising over half of these minor species.

In October 1992, mean forage production from the reseeded area was 3900 kg/ha compared to 400 kg/ha from the native range. The 1992 and 1993 species frequency and forage production data are given in Table 1. Total plant production from reseeded and natural range was 1251 kg/ha and 534 kg/ha, respectively, in 1993. Higher forage production during 1992 compared to that of 1993 may have resulted from higher precipitation during the year. Total precipitation for 1991, 1992 and 1993 was 158, 92 and 55 mm, respectively. During all 3 years precipitation mostly occurred from August to September, the forage growing season.

4.2. Chemical composition of forage

The chemical composition of the forage species sampled indicate chimber, a native grass, was lower in crude protein (5.9%) and digestible energy (2.4 Mcal/kg) than the introduced grasses, Buffel and Gorkha (Table 2). Buffel had the highest (7.8%) crude protein value for grasses followed by Gorkha (6.2%) and then chimber (5.9%). The shrub lana had the highest crude protein (11.5%) of all forage species sampled. Except for gorkha, the energy values were higher for lana and phog compared to the grasses. This investigation was consistent with research conducted by Short et al. (1974) and Holechek et al. (1989). These authors reported during active growth forbs have the highest crude protein, phosphorous and cell solubles. Shrubs were intermediate, while grasses had the lowest concentration of these constituents.

4.3. Sheep and goats performance

Sheep and goats grazing both treatments were weighed monthly between February and December, 1993 (Fig. 1). During this 334-day period goats and sheep had a mean weight gain of 34 and 14 g/day, respectively. Sheep gained weight from February to August but lost weight from September to December while goats gained liveweight throughout the study period. Liveweight gains were greater during the early growing season for both animal species probably due to the higher nutrient contents of the forage. Similar observations had been made by Holechek (1984). During the dry period of the year (May to June) sheep lost liveweight while goats continued to gain in liveweight probably as a result of changing their diet to include leaves and flowers and fruits of shrubs. Similar observations were made in Kenya by Schwartz and Said (1981) where flowers and fruits of *Acacia* sp. represented the major portion of goats diets during the dry season. In Pakistan, Rehaman et al. (1990) reported that during the winter season December to February when grass species are dormant and available forage quality is low, fourwing salt bush serves as a major forage species for small ruminants in Baluchistan. Because goats appear to be more adaptable to

Table 2
Chemical composition of Important Forage Species as determined using AOAC (1985) procedures harvested from Thatta Leghari rangeland of Pakistan during July to September 1993

Item	Grasses			Shrubs	
	Buffel[a]	Gorkha[a]	Chimber[b]	Lana[b]	Phog[b]
DM (%)	91.3	93.6	93.6	89.3	93.3
CP (%)	7.8	6.2	5.9	11.5	8.4
Ether Extract (%)	1.5	1.8	2.4	2.4	1.8
Crude Fibre (%)	24.7	38.6	29.1	33.5	37.8
TDN (%)	58.4	61.3	63.9	71.2	61.2
DE (Mcal/kg)	2.6	2.7	2.4	3.1	2.7
ME (Mcal/kg)	2.2	2.3	1.5	2.7	2.3

[a]Introduced species.
[b]Native species
DM=Dry Matter; CP=Crude Protein (N% × 6.25); TDN=Total Digestible Nutrient; DE=Digestible Energy, Mcal/kg; ME=Metabolizable Energy.

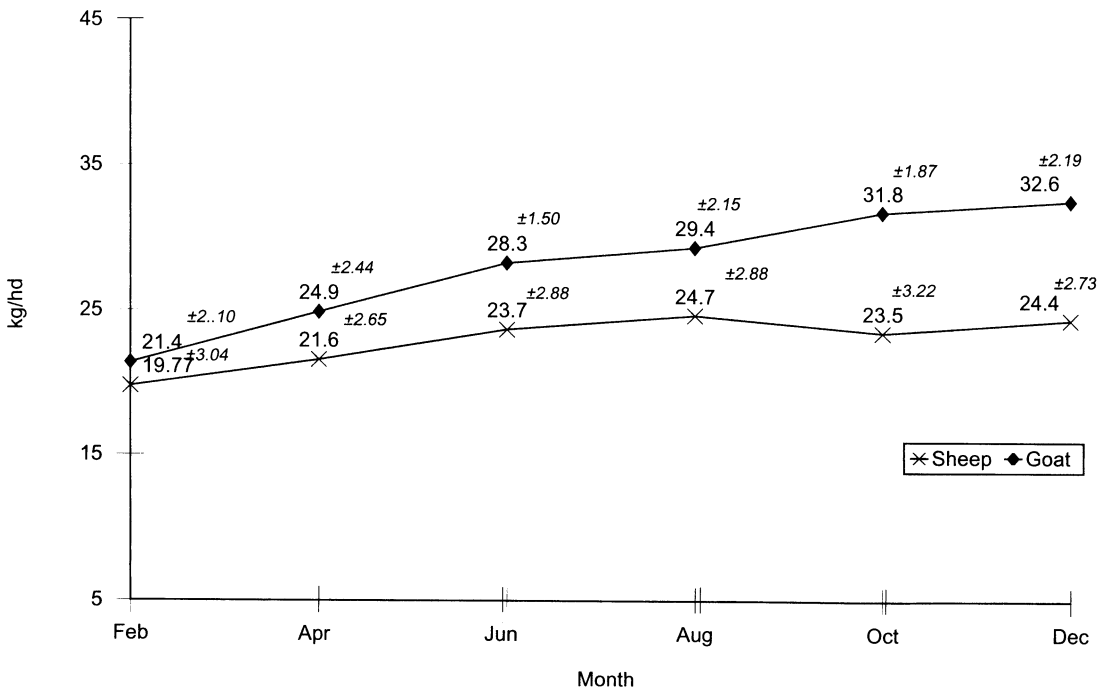

Fig. 1. Mean Live weight gain by sheep and goats during 1993 while grazing Dera Ghazi Khan Rangeland in Pakistan.

changing diets than sheep, they are ideal candidates for marginal rangeland (Malechek and Provenza, 1983).

4.4. Foraging and non-foraging behavior

Sheep and goats were observed throughout 11 h of daylight during morning (07:00–12:00 hours) and afternoon (13:00–18:00 hours) sampling periods over 5 consecutive days at the end of November and beginning of December, 1993 on Dera Ghazi Rangeland. The protocol for an observer to follow an animal for 15 min and manually recording data on paper sheets while within 1 m of the animal did not appear to alter the behavior of the animal being observed.

Based on the percentage of time sheep and goats were observed foraging, sheep ate more (p=0.001) grass, less (p=0.0001) shrubs, less (p=0.0003) poisonous plants and about the same (p=0.2087) amount of forbs compared to goats (Table 3). These findings support previous research that goats prefer shrubs (Bryant et al., 1979; Malechek and Provenza, 1983). Percentage wise the non-foraging behavior of lying and standing were observed in about equal (p>0.05) amounts throughout the day for both sheep and goats. However, the goats were observed percentage-wise to be involved in more (p=0.0001) non-foraging behavior than were sheep.

If the animals urinated or defecated while observed the behavior was recorded. However, the information was not considered in calculating percent of time spent in a non-foraging activity because of the relatively short duration and infrequent intervals at which they occurred compared to standing and lying. Goats were observed to urinate and defecate more frequently than the sheep. Hulet et al. (1975) reported the number of urinations and defecations for sheep are 9 to 13 and 6 to 8, respectively. Attempting to interpret the apparent species difference is not possible since number of defecations and urinations for goats apparently does not exist (Arnold and Dudzinski, 1978).

Grass was predominantly (p=0.00001) grazed during the morning (07:00–12:00 hours) by both sheep and goats. Goats were not observed to graze Chimber while sheep ate about twice as much of this plant in the morning compared to the afternoon (12:01–18:00 hours). Though Buffel was eaten by both sheep and goat, percentage-wise more (p=0.0018) of this grass was consumed in the morning by both animal species

Table 3
Least square means (%) and standard error of foraging and non-foraging behaviors[a] of ten sheep and ten goats randomly observed among 5 days in November and December 1993 between 07:00 and 18:00 hours while animals were foraging on reseeded or native, Dera Ghazi Rangeland in Pakistan

Behaviours[a]	Sheep				Goats			
	AM		PM		AM		PM	
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Foraging								
Eleusine flagellifera –Chimber	18.3	1.7	9.5	1.7	0	0	0	0
Cenchrus ailiaries – Buffel	6.9	1.7	2.9	1.7	10.2	1.8	1.1	1.8
Lasiurus sindicus – Gorkha	18.6	1.9	5.8	1.9	10.0	2.1	3.2	2.1
Total grasses	43.8	2.0	18.2	2.0	20.2	2.1	4.3	2.1
Aerva javanica – Bui	6.5	1.7	5.8	1.7	3.4	1.8	0.3	1.8
Salsola foetida – Lana	15.0	2.4	6.1	2.4	18.2	2.6	10.4	2.6
Aristida depressa – Lumbi	7.7	1.4	3.7	1.4	8.5	1.5	1.2	1.5
Miscellaneous	16.4	2.8	9.4	2.8	15.9	3.0	3.7	3.0
Total forbs	45.6	2.3	24.9	2.3	46.0	2.4	15.6	2.4
Calligoum polygonoides –Phog	4.7	1.7	5.8	1.7	12.6	1.8	7.1	1.8
Acacia jaequemontic – Trleaf; *Zizyphus jujuba*, etc.	4.4	2.8	49.2	2.8	14.7	3.0	68.6	3.0
Total shrubs	9.1	2.5	55.0	2.5	27.3	2.4	75.1	2.7
Total grasses, forbs and shrubs	98.5	1.2	98.1	1.2	90.8	1.8	95.5	1.3
Poisonous plant	1.5	1.2	1.9	1.2	8.7	1.2	4.5	1.2
Non-forgaging								
Standing	15.0	6.2	18.0	6.2	23.0	6.6	15.5	6.6
Lying	2.0	5.4	0	0	17	5.7	6.5	5.7

[a]The data recorded to obtain percentages were activity codes (foraging or non-foraging) at each point in time and not minutes the animal spent in each activity.

compared to the afternoons. Sheep ate more (p=0.0028) Gorkha than goats and both sheep and goats preferred (p=0.0001) to eat this grass during the mornings.

Sheep and goats were observed to graze more (p=0.0001) forbs in the morning than in the afternoons (Table 3). Sheep appeared to prefer (p=0.0002) Bui more than goats throughout the day. In contrast, Lana and Lumbi were used about equally by both animal species and were preferred ($p \leq 0.0037$) during the mornings compared to the afternoons. In general, those forbs not identified as to genus or species were classified as miscellaneous and were preferred equally (p=0.2308) by sheep and goats but were grazed more (p=0.0035) in the mornings than in the afternoons.

Only two shrubs were observed to have been browsed by the sheep and goats (Table 3). The Phog was utilized similarly (p=0.0995) by sheep and goats in about the same (p=0.2393) proportions throughout the day. However, goats ate substantially more (p=0.0001) Trleaf than sheep did, with afternoon browsing preferred (p=0.0001) to morning browsing of this plant. Possibly as a result of the Trleaf consumption goat mean liveweight exceeded those of the sheep. These data support those of Rafique et al. (1992) who found shrubs and forbs improve diet quality in small ruminants fed low quality grass hay.

Ak (*Calotropise procera*) a poisonous plant was preferred by goats. Among the poisonous species goats tended to eat more (p =0.00003) Ak plants than did sheep with time of day not affecting consumption.

5. Conclusion

Reseeding arid rangeland with palatable species followed by controlled sheep and goat stocking provided livestock diets that resulted in improved live-

weight gain compared to that from native rangeland. Furthermore, because of heterogenous vegetation, mixed species stocking should improve utilization compared to a single species stocking.

Our data show sheep and goat non-foraging behaviors (lying and standing) were similar between the sheep and goats. However, foraging behavior differed between the sheep and goats. By evaluating liveweight data together with the diet data it appears goats regardless of range type (native vs. reseeded) performed better than sheep even though their initial mean liveweights were similar at the beginning of the study. However, where the reseeded grass Gorkha was available sheep utilized more of it as a percentage of their grazing time than did goats. Sheep and goats utilized some of the four native species documented in their diets while goats utilized only three of the species and completely avoided Chimber. Because foraging and non-foraging data were taken in only one season, in 1993, no predictions should be drawn from these data concerning the affect of reseeding on small ruminant production.

This study, though preliminary, can provide general guidelines for a remediation model for the inhabitants of the Thatta Leghari Rangelands of D.G. Khan, Pakistan. The information also contributes to the knowledge of sustainable systems in reducing desertification of semi-arid lands elsewhere in the world where similar environmental and social conditions exist.

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