EFFECTS OF FERTILIZER, EXCLOSURE, CLIPPING AND GRAZING ON FLORISTIC DIVERSITY OF THE MOIST TEMPERATE GRAZING LANDS

Sardar Muhammad Rafique*

Abstract

The study was carried out at Kund, Shinkari during May 1989 to September, 1995. Three main treatments namely; one final cutting, two clipping and continuous (conventional) grazing were tested in 10 x 10 metres plots. Each plot was sub divided in 10 x 5 metres and chemical fertilized was applied in one sub-plot under each major treatment at the uniform single dose of NPK (1:2:2) at the rate of 100 Kg N, 200 Kg P and 200 Kg K. The experiment was twice replicated.

The study has revealed that floristic composition of grass and forbs species had improved manifolds. The vegetation cover percentage, herbage production, species composition, species distribution and number of species had increased under combined effects of protection and fertilizer application. The *Poa alpina - Potentilla fragarioides* vegetation type was transformed to *Poa alpina - Digitaria sanguinalis* types. This change had also registered increase in species number from 18 to 27. One final clipping and two clippings have no appreciable effect on floristic composition however, two clippings had caused slight increase in forage production. The study has demonstrated that poor temperate rangelands could be rehabilitated by application of suitable fertilizer and control grazing for about 5 years.

Introduction

Summer grazing in the moist temperate forests of the northern mountainous region of the North West Frontier Province (NWFP) of Pakistan is a common practice both by local and nomadic livestock graziers. Due to uncontrolled, heavy, centuries old grazing and lack of

* Range Management Officer, Pakistan Forest Institute, Peshawar.

technical input, forest gaps have been created. Further the retrogression due to selective grazing and trampling has also set in at a number of such forest gaps. Although most of mountain forests are state property even then they are burdened with grazing rights and concessions to the local farmers. Subsequently grazing pressure is expected to increase manifolds with increase in human and livestock population.

The temperate forest grazing lands are located between 2000 to 3000 meters elevation above sea level. The area receives more than 1700 mm rainfall most of which falls in Monsoon (July-September), July being the wettest month. Winter receives snowfall and ground remains covered with snow from December to April. Mean maximum temperature is 22°C in June. Soil is blackish brown loamy silt and moderately acidic. Organic matter contents and total soil Nitrogen are high with moderate level of Potassium. Available Phosphorus level is low (Sardar, 1994).

This study, primarily, was carried out to assess the forage production potential of forest gaps in moist temperate forest through grazing management and application of fertilizer. Information on floristic composition was also collected. The study was maintained for 7 years (1989-95).

Material and Methods

Two sites located along Kund-Shaeed Pani Road on a ridge, a watershed divide of Siren and Kunhar valleys, were selected. Both the sites were located in a narrow blank strip which were used as grazing ground by local livestock and as grazing and resting camp by the nomadic livestock. The moist temperate mixed coniferous forests were found along the eastern and western directions of both the sites. Site-I was located at foot of a spur in compartment No.11 (ii) Punjul Reserved Forest (RF) at an elevation of 2500 m. Site-II was located at flat ridge top in compartment No.10 (i) Punjul R.F. at an elevation of 2650 m.

The experiment was laid out during the third week of May, 1989 using both randomized complete block (RCB) design and split plot design at both the sites. Three main variables namely; A=control (one final

clipping), B=simulation rotation grazing (two clippings) and C= conventional grazing (continuous grazing) were tested. Three contiguous plots of 10 x 10 m size were demarcated at both sites. The major variables were assigned randomly to each plot. The plots having variable A and B were fenced and C was kept open to conventional grazing. Each plot was divided into two sub plots of equal size of 10 x 5 m. Accordingly, there were 6 sub plots viza viz a_1, a_2, b_1, b_2, c_1, c_2 at each site. Ten semi-permanent quadrats of 1 x 1 m size were laid out in each sub-plot for vegetation analysis. A uniform single dose of NPK (1:2:2) at the rate of 100 Kg N, 200 Kg P and 200 Kg K per hectare was applied to a_1, b_1 and c_1 during mid July each year under split plot design. The fertilizer was applied for first 3 years only, however, its residual effects were evaluated for next 4 years (1993-95).

Data regarding floristic composition was collected from 120 semi-permanent sample plots of 1 square meter. Cover percentage of each species in sample plot was recorded by ocular estimation. First time data was collected in June, 1989. Subsequently, data was collected in mid July and 3rd week of September every year. For this paper data collected during June, 1989 and in September each year are reported. For comparison average data for 3 years (1989-91) showing fertilizer effect and data for next 4 years (1992-95) showing residual effect of fertilizer are reported. All figures are given in percentage and average values.

Results and Discussion

1. Vegetation Life Form:

Only grasses and forbs species were found at both the study sites (forest gaps). In June and early summer growing season, total areal cover was 46.7 percent. Of which 27.9 percent was of forbs and 18.8 percent was of grasses. Forbs had 9 percentage points higher cover (Table 1 under a.)

Fertilizer and exclosure (protection) had marked influence on cover values of both grasses and forbs. total cover of both the life forms was 86.0 percent. Of it 52.6 percent cover was of grasses and 32.4 percent

cover was of forbs. The increase in grass cover (20.2 percentage point) was mainly due to application of fertilizer. Grasses seemed more responsive to fertilization. Under sub plot a_1 which was fertilized and protected the grass cover (77.1%) was 34.3 percentage points higher than a_2 which was unfertilized and protected. Same was true for b_1 and b_2 values. On other hand, forbs cover in a_1 (20.5%) was 26.1 percentage points lower than a_2. Same response was recorded in b_1 and b_2 plots (Table 1 under b.).

Clipping had no appreciable effect on cover percentage values of both grasses and forbs. In the experiment both the sub plots a_1 and a_2 under variable A were clipped once at final growth stage (October) of grass growth. Under variable B both the sub plots b_1 and b_2 were clipped twice at mid growth stage August and final stage of the growth. Grass cover values under a_1 and b_1 and a_2 and b_2 were more or less of same magnitudes. Same was true for forbs cover value (Table 1 under b.).

Under residual effect average cover (86.7%) was a slighter higher than fertilizer effect. Of which forbs cover was 42.6 percent and grass cover was 44.1 percent. Forb cover under residual effect was 9.2 percentage points higher than the forb cover (33.4%) under fertilized condition. The decrease in grass cover under residual effect was balanced out by the increase in forbs cover at this stage (Table 1 under c.).

There was no appreciable difference in Fertilizer and its residual effects on the grass cover values. Same trend was recorded in cover of the forbs species (Table-1_b and 1_c). The difference in grass cover before experimentation and fertilization or residual could be attributed to the growing season. Similarly, there was no appreciable difference in cover values of C_1 (fertilized) and C_2 (unfertilized) plots. This indicates that after fertilizer application grazing has to be stopped for at least a season or so to achieve the desired effect.

Table 1 Cover Percentage Values of Different/life forms in the study area

Life form	A		B		C		Average
	a_1	a_2	b_1	b_2	c_1	c_2	
a. Before treatment (June, 1989)							
Grass	27.1	13.5	9.8	13.4	20.6	28.1	18.8
Forbs	33.6	29.5	16.8	27.4	28.8	31.3	27.9
Total:	60.7	43.0	26.6	30.8	49.4	59.4	46.7
b. After fertilization (September 1989-91)							
Grass	77.1	42.8	75.6	39.8	44.0	36.3	52.6
Forbs	20.5	46.6	27.9	47.0	27.6	30.6	33.4
Total	97.6	89.4	103.5	86.8	71.6	66.9	86.0
c. Residual effect (September 1992-95)							
Grass	66.5	40.2	45.6	33.8	43.9	34.6	44.1
Forbs	42.6	60.8	49.0	56.2	21.0	25.9	42.6
Total:	108.1	101.0	94.6	90.0	64.9	60.5	86.7

2. Herbage Production:

Average annual air dried (DM) herbage production under plot a_1 (fertilized, protected and one clipping) was 3930 kg/ha. It was about 60 percent higher than a_2 plot (2446 kg/ha DM) which was unfertilized. Similarly in plot b_1 (fertilized + twice clipped) herbage production (4351 kg/ha DM) was 39 percent higher than b_2 (unfertilized). This clearly indicates a that fertilizer increased the biomass production (Table 2). This is further confirmed by lower production values under residual effects.

Two or more clippings also increased biomass production over one clipping. Herbage production in plots of two clippings (b_1 and b_2) were 11 and 27 percent higher than plots of one clipping (a_1 and a_2) respectively (Table 2). This indicated that moist temperate ground vegetation has positive response to clippings (grazing). Once the ecological recovery is

attained by the sites its further vigor could be enhanced by range improvement activities.

Table 2. Influence of fertilizer, exclosure and clippings on annual herbage production

(kg/DM)

Period	A		B		C	
	a_1	a_2	b_1	b_2	c_1	c_2
September 1989-91 (Average for 3 years)	3930	2446	4351	3119	-	-
September 1992-95 (Average for 4 years)	3110	1600	3227	2047	-	-

3. Floristic composition:

Prior to experimentation 6 grass species and 12 forb species were found at the study sites. Among grasses *Poa alpina* (13.8 % cover) had 73 percent composition followed by *Agrostis gigantea* (2.9% cover) which had 15 percent composition. Among forbs *Potentilla fragarioides* (8.6% cover) had 31 percent composition followed by *Trifolium repens* (7.6% cover) which had 27 percent composition (Table 3). Accordingly, *Poa alpina - Potentilla fragarioides* vegetation type was found in the forest gaps of moist temperate forest at about 2500 m elevation ASL.

After three years of fertilization, exclosure and clippings 9 grasses/grass likes and 18 forbs species were recorded. *Poa alpina* (26.8%) had highest composition (51 percent) followed by *Digitaria sanguinalis* (10.9% cover) which had 21 percent composition. This grass species had increased from 0.1 percent cover to 10.9 percent cover; a 108 times increase. This species seemed very responsive to treatments. Among forbs *Trilolium repens* (10.4% cover) and *Potentilla fragarioides* (10.4% cover) each had 32 percent composition (Table 4). The treatment had caused decrease in cover percentage of many species though the number of forbs species had increased.

Fertilizer application and protection from grazing have increased the number of species both of grasses and forbs. The cover percentage and species composition were as low as prior to experimentation under free grazing. After experimentation *Poa alpina - Digitaria sanguinalis* type of community was recorded.

After 4 years of discontinuation of fertilizer application, with no change in other treatments, the number of grasses and forbs species remained the same. However, the grass cover had decreased and forb cover had increased. *Poa alpina* remained abundant species with 42 percent composition followed by *D. sanguinalis* with 25 percent composition. Similarly *T. repens* had highest (36 percent) composition among the forbs species. It was followed by *P. fragarioides* having 28 percent composition(Table 5). *Poa alpina-T. repens* type vegetation was recording the residual effect.

Table 3 Floristic composition of moist temperate forest grazing lands (June, 1989).

(cover percent)

Species	A		B		C		Average
	a_1	A_2	b_1	b_2	c_1	c_2	
1. Grasses/grass like							
Agrostis gigantea	13.0	2.3	0.2	0.9	0.8	2.9	2.9
Bothriochloa intermedia	0.3	-	-	-	-	-	0.1
Carex sp.	3.4	1.2	1.6	2.2	1.2	0.5	1.7
Chrysopogon echinulatus	-	-	-	-	-	0.5	0.1
Digitaria sanguinalis	-	-	-	-	-	0.5	0.1
Poa alpina	10.4	10.0	8.0	9.1	19.0	26.3	13.8
Sub total grass	27.1	13.5	9.8	13.4	20.6	28.1	18.8
2. Forbs							
Cerastium friviale	0.5	0.2	0.4	0.2	0.2	0.1	0.3
Filago spathulata	0.3	-	-	-	-	-	0.1
Plantago lanceolata	6.8	4.3	2.3	4.3	12.2	5.8	6.0

Species	A		B		C		Average
	a_1	A_2	b_1	b_2	c_1	c_2	
Potentilla fragarioides	10.4	10.0	5.0	6.1	9.3	10.7	8.6
P. sibbaldi	7.8	2.9	-	2.6	2.3	2.7	3.1
Polygonum amplexicaule	-	-	-	-	0.2	-	0
Ranunculus laetus	0.1	0.3	0.2	0.3	0.6	2.0	0.6
Rumex nepalensis	0.4	2.1	0.5	0.5	0.4	0.7	0.8
Taraxacum officinale	1.5	1.5	0.1	2.3	-	0.4	0.9
Trifolium repens	5.8	8.2	8.3	11.1	3.6	8.7	7.6
Veronica laxa	-	-	-	-	-	0.2	0
Sub-total forbs:	33.6	29.5	16.8	27.4	28.8	31.3	27.9
Total:	60.7	43.0	26.6	40.8	49.4	59.4	46.7

4. Species abundance:

In June, 1989 the highest frequency (86 percent) among grasses was of *Poa alpina* followed by Carex sp. (74%). The lowest frequency (1 percent) was of *Bothriochla sp. and Chrysopogon sp.* Among forbs *Plantago lanceolata* had highest frequency (95 percent) followed by *T. repens* (94 percent), (Table 6). Both *T. repens* and *Poa alpina* were very abundant in the study area prior to experimentation.

Application of fertilizer and protection from grazing had not only improved the distribution of existing species but had also increased species during the study period. *Poa alpina* had highest frequency (98 percent) followed by the *Digitaria sanguinalis* (85 percent). Similarly *Trifolium repens* had 93 percent frequency followed by *Potentilla fragarioides* which had 91 percent frequency (Table 7). All these species were uniformly distributed in the study sites.

After discontinuation of fertilizer minor changes were recorded in the frequencies of very abundant species. *Poa alpina* had 88 percent frequency

Table 4 Effect of fertilizer, exclosure, grazing and clipping on floristic composition (September, 1989-91)

(Average cover percent values)

Species	A		B		C		Avg.
	a_1	a_2	b_1	b_2	c_1	c_2	
1. Grasses/grass like							
Agrostis gigantea	12.8	4.5	12.4	10.6	5.7	3.6	8.3
Bothriochloa intermedia	1.0	1.0	-	0.1	-	0.1	0.4
Carex sp.	5.2	4.0	7.2	4.4	2.7	1.8	4.2
Chrysopogon echinulatus	-	-	0.1	1.0	-	-	0
Dactylis glomerata	-	-	0.5	-	-	-	0.1
Cynodon dactylon	0.3	0.9	-	-	-	-	0.2
Digitaria sanguinalis	20.0	6.3	15.23	11.4	7.3	5.2	10.9
Pennisetum lanatum	3.94	3.40	-.0	1.4	-	-	1.5
Poa alpina	33.9	21.7	40.2	10.9	28.3	25.6	26.8
Sub total grass:	77.1	42.8	75.6	39.8	44.0	36.3	52.6
2. Forbs							
Ajuga parviflora	0.1	0.3	0.2	-	-	-	0.1
Cerastium friviale	0.3	0.8	1.2	1.3	0.2	0.1	0.7
Conyza japonica	0.1	-	0.1	0.4	-	-	01
Cynoglossum lancelatum	0.1	-	-	-	-	-	0
Geranium sibiricum	0.8	0.4	-	-	0.3	-	0.2
Lespedeza sericea	0.1	-	-	-	-	-	0
Plantago lanceolata	2.4	5.8	1.5	3.1	9.3	5.2	4.6
Potentilla fragarioides	6.4	19.2	6.1	15.0	5.12	10.6	10.4
P. sabbaldi	0.7	1.0	-	0.4	2.18	2.63	1.1
Polygonum aviculare	1.0	1.0	-	0.3	-	0.3	0.5
Polygonum amplexicaule	1.1	-	-	-	0.1	0.3	0.3
Polygonum nepalense	0.2	0.3	0.2	-	0	-	0.1
Phlomis bracteosa	1.6	1.0	1.5	1.0	0.1	0.5	1.0
Ranunculus laetus	0.3	0.9	0.2	0.6	0.4	1.7	0.7
Rumex nepalensis	0.7	0.9	1.2	0.7	0.7	0.5	0.8
Taraxacum officinale	1.0	1.4	1.1	0.8	-	0.9	0.9
Trifolium repens	3.7	11.2	12.3	19.0	8.8	7.1	10.4
Veronica laxa	-	2.4	1.7	4.3	-	0.8	1.5
Sub-total forbs:	20.5	46.6	27.9	47.0	27.6	30.7	33.4
Total:	97.6	89.4	103.5	86.8	71.6	66.9	86.0

Table 5: Residual effect on floristic composition (September 1992-September, 1995)

(Average cover values)

Species	A		B		C		Average
	a_1	a_2	b_1	b_2	c_1	c_2	
1. Grasses/grass like							
Agrostis gigantea	17.2	2.6	8.24	8.06	5.3	3.5	7.5
Bothriochloa intermedia	1.0	1.0	-	0.2	-	0.2	0.4
Carex sp.	4.9	3.3	11.2	4.0	2.5	1.5	4.6
Chrysopogon echinulatus	-	-	0.1	2.1	-	-	0.4
Cynodon dactylon	1.2	0.9	-	-	-	-	0.4
Dactylis glomerata	-	-	0.5	-	-	-	0.1
Digitaria sanguinalis	1.2	0.9	-	-	-	-	0.4
Pennisetum lanatum	3.0	3.3	-	1.6	-	-	1.3
Poa alpina	20.0	22.1	13.6	5.7	25.8	24.5	18.6
Sub total grass:	66.5	40.2	45.6	33.9	43.9	34.6	44.1
2. Forbs							
Ajuga parviflora	0.1	0.3	0.2	0.1	-	-	0.1
Arisaema wallichianum	-	-	0.1	-	-	-	0
Cerastium friviale	0.2	1.3	1.7	1.8	-	-	0.8
Conyza japonica	-	-	0.8	0.5	-	-	0.2
Chenepodium album	4.0	3.0	2.0	-	-	-	1.5
Cynoglossum lanceolatum	0.2	0.1	0.1	-	-	-	0.1
Geranium sibiricum	-	0.6	0.5	-	-	-	0.2
Plantago lanceolata	1.5	5.5	5.7	2.6	6.72	4.7	4.5
Potentilla fragarioides	9.1	23.1	10.9	15.5	3.4	9.57	11.9
P. sabbaldi	0.5	0.4	-	0.1	1.1	2.1	0.7
Polygonum aviculare	1.5	0.4	3.4	0.3	0.2	-	1.0
Polygonum amplexicaule	1.7	0.6	-	-	-	-	0.4
Phlomis bracteosa	0.2	1.0	1.3	0.1	0.7	1.6	0.8
Ranunculus laetus	0.2	1.0	1.3	0.1	0.7	1.6	0.8
Rumex nepalensis	0.6	0.1	0.7	0.5	0.5	0.4	0.5
Taraxacum officinale	1.0	2.4	1.0	0.2	0.1	0.7	0.9
Trifolium repens	18.5	15.3	16.2	26.9	8.3	6.0	15.2
Veronica laxa	-	5.3	2.3	6.7	-	0.6	2.4
Sub-total forbs:	42.6	60.8	49.0	56.2	21.0	25.9	42.6
Total:	109.1	101.0	94.6	90.1	64.9	60.5	86.7

Table 6Species frequencies in moist temperate forest grazing land (June, 1989)

(Percent values)

Species	A		B		C		Avg.
	a_1	a_2	b_1	b_2	c_1	c_2	
1. Grasses/grass like							
Agrostis gigantea	80	100	35	90	75	60	73
Bothriochloa intermedia	5	-	-	-	-	-	1
Chrysopogon echinulatus	-	-	-	5	-	-	1
Carex sp.	9	90	90	85	60	35	74
Digitaria sanguinalis	-	10	-	-	-	10	3
Poa alpina	45	100	100	70	100	100	86
2. Forbs							
Cerastium friviale	35	45	40	20	10	15	28
Filago spathulata	25	-	-	-	-	-	28
Plantago lanceolata	85	95	95	100	100	95	95
Potentilla fragarioides	100	50	100	100	95	95	90
P. sabbaldi	50	50	45	40	45	40	45
Polygonum aviculare	-	-	-	-	5	5	2
Ranunculus laetus	5	20	15	20	15	35	18
Rumex nepalensis	10	40	5	15	10	15	16
Taraxacum officinale	60	60	40	40	35	25	43
Trifolium repens	80	95	90	100	100	100	94
Veronica laxa	-	-	-	-	-	5	1
Total forbs:	42.6	60.8	49.0	56.2	21.0	25.9	42.6

Table 7Effect of fertilizer, exclosure, grazing and clipping on species frequencies (3 years average of 1989-91)

(Average frequencies percent values)

Species	A		B		C		Avg.
	a_1	a_2	b_1	b_2	c_1	c_2	
1. Grasses/grass like							
Agrostis gigantea	70	55	88	85	70	57	71
Bothriochloa intermedia	5	5	-	4	-	5	3
Carex sp.	65	82	80	80	75	72	73
Chrysopogon echinulatus	-	2	-	10	-	-	2
Cynodon dactylon	75	85	80	92	98	82	85
Digitaria sanguinalis	-	-	2	-	-	-	-
Dactylis glomerata	5	12	-	5		-	-
Pennisetum lanatum	5	12	-	5	-	-	4
Poa alpina	95	100	100	93	100	98	98
2. Forbs							
Ajuga parviflora	2	10	2	-	-	-	2
Cerastium friviale	18	55	60	20	12	-	28
Conyza japonica	-	15	7	7	-	-	5
Cynoglossum laceolatum	2	12	13	2	-	-	5
Geranium sibiricum	10	10	5	-	2	-	5
Lespedeza sericea	2	-	2	-	-	-	1
Plantago lanceolata	33	94	44	88	83	87	72
Potentilla fragarioides	85	78	92	100	90	100	91
P. sibbaldi	8	25	20	7	30	25	19
Polygonum aviculare	35	18	28	25	12	3	20
Polygonum amplexicaule	-	-	-	-	-	-	-
Polygonum nepalense	27	-	5	2	-	-	6
Phlomis bracteosas	35	40	42	60	1	5	31
Ranunculus laetus	2	13	7	10	16	25	12
Rumex nepalensis	15	38	12	14	10	14	17
Taraxacum officianale	21	38	35	20	20	22	26
Trifolium repens	70	100	88	100	100	100	93
Veronica laxa	-	47	12	18	5	15	16

Table 8Residual effect on frequencies of different species, (4 years

(Average frequencies percent values)

Species	A		B		C		Average
	a_1	a_2	b_1	b_2	c_1	c_2	
1. Grasses/grass like							
Agrostis gigantea	75	53	100	70	39	49	64
Bothriochloa intermedia	4	5	-	5	-	5	3
Carex sp.	78	80	97	72	68	61	76
Chrysopogon echinulatus	-	2	-	10	-	-	2
Cynodon dactylon	-	15	-	-	-	-	3
Digitaria sanguinalis	70	88	90	89	94	74	84
Dactylis glomerata	-	-	2	-	-	-	-
Pennisetum lanatum	5	12	-	5	-	-	4
Poa alpina	75	86	100	74	100	90	88
2. Forbs							
Ajuga parviflora	1	5	3	-	-	-	2
Arisaema wallichianum	-	-	-	-	-	-	-
Cerastium friviale	1	56	48	24	42	10	24
Chenopodium laceolatum	37	25	12	-	-	-	12
Conyza japonica	-	16	8	7	-	-	5
Cynoglossum laceolatum	10	14	24	2	-	-	8
Geranium sibiricum	3	8	2	-	3	-	3
Mentha longifolia	1	-	-	-	-	-	-
Plantago lanceolata	42	94	80	65	65	70	69
Potentilla fragarioides	77	100	100	100	88	100	94
P. sibbaldi	-	7	-	5	-	-	2
Polygonum aviculare	28	20	25	26	-	-	17
Polygonum amplexicaule	-	6	22	-	-	-	5
Polygonum nepalense	14	-	5	-	-	-	3
Phlomis bracteosas	81	62	90	65	-	5	51
Ranunculus laetus	5	9	10	6	125	20	11
Rumex nepalensis	12	38	10	12	10	14	16
Taraxacum officianale	18	38	58	15	-	20	25
Trifolium repens	95	100	100	100	100	100	99
Veronica laxa	-	65	36	87	15	15	36

followed by *D. sanguinalis* which had 84 percent frequency. Similarly *T. repens* had 99 percent frequency followed by *P.fragarioides* which had 94 percent frequency(Table 8).

Conclusion

Biodiversity of moist temperate forest ranges can be restored by appropriate use of fertilizer and protection from free grazing for a period of 5 years or so. This improves the cover percentage, herbage production, species composition, species distribution and brings early ecological recovery. The number of species had increased from 18 to 27 due to improvement activities. The *Poa alpina - Potentilla fragarioides* type of vegetation was converted to *P. alpina - Digitaria sanguinalis* type with their higher cover percentage values and higher number of associates. However, the residual effect converted this type of vegetation to *Poa alpina-Trifolium repens* type without any further increase in the number of their associates. Similarly the average cover percentage values were enhanced to 86.0 from 47. The values found prior to experimentation. The residual and exclosure had further slightly increased the average cover percentage value to 87.0 percent. One final clipping at the end of growing season or two clippings, one at mid growing season and one final clipping do not help enhance the biodiversity.

Fertilizer application, protection from free grazing and two clippings enhanced herbage production. Fertilization alone increased herbage production by 60 percent than no fertilization. This not only improved the species performance but also improved the nutritional values of the local herbage. Further it enhanced the growing period and local vegetation tended to remain green for longer period.

References

Sardar, M. Rafique. 1994. Effect of grazing management and fertilizer application on vegetation and soil properties of a moist temperate forest range in Siren valley (Mansehra). Pak. J.F. 44 (1): 20-29.

Stejnbrenner, F.C. 1951. Effect of grazing on floristic composition and soil properties of farm woodlands in southern Wisconsin. J. For. 49: 906-910.