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Ecological Assessment of Production Potential for Rangeland Vegetation in Southern Attock, Pakistan

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ABSTRACT

Two main ecological units already established were further sub-divided into protected (mapping units 1.1 & 2.1) and un-protected (mapping units 1.2 & 2.2) areas on the basis of their vegetation making four ecological subunits. In these ecological subunits dry matter forage production was determined. Analysis of variance between protected forest and un-protected open grazing areas of each ecological unit showed highly significant differences. The difference between transects/aspects of each ecological unit and sub-unit was found non-significant. The un-protected open grazing areas showed 1.8 to 2.0 times decline in carrying capacity. The open grazing areas of ecological units 1 and 2 have 105 and 79.3% development potential, respectively in terms of carrying capacity (Animal Units per Year) per hectare, if simply be protected from open grazing and can be increased more by improved system of grazing management.

Key Words: Rangeland; Vegetation; Grazing; Production potential

INTRODUCTION

Growth of human population has increased the demand for livestock production. It in turn has exerted the pressure on rangeland resources resulting in degradation and depletion of vegetation. During the vegetation study of Hazarganji reserve forest, Khan and Hussain (1960) found that vegetation inside the enclosure was 26 - 28% better in terms of coverage of trees and palatable grasses, particularly the perennial ones were only present inside the enclosure. Noor (1978) recorded threefold increase in forage production inside an enclosure at Saripaya in Khaghan. Ashfaque and Amin (1982) in a comparative study of forage production observed five times increase in forage production in the protected area. Beg *et al*. (1987) assessed the production of Pothwar for ten crops under rain fed conditions. Ahmad *et al*. (1989) studied the effect of exclosure in Bannigala forest and found an increase of 197% in forage production under protected conditions. Noor (1989) studied the vegetation changes due to closure at Juba sheep farm and observed nine times increase of forage production inside the closure. Raza and Ahmad (1990), while studying the production potential of Pindi Gheb area, determined 147% and 638% development potential of un-protected and protected areas, respectively. Ahmad *et al*. (1997) compared the forage production of grazed and un-grazed areas at Fateh Jang (Pothwar), under rain fed conditions and observed an increase of about 372% of forage production (dry matter yield), in the protected areas as compared to that of un-protected. Manske (2004) purposed that properly timed grazing that removes only a small portion, about 10% to 33%, of the leaf material from grasses. Liebig *et al.* (2006) studied the effect of grazing management on soil and suggested that fertilized crested wheat grass enhanced deep storage of soil organic carbon in northern Great Plains of North America.

The objectives of the present study were quantitative estimation of environmentally sound rangeland forage production potential and carrying capacity for proper livestock development.

Climate. The area lies between elevations of 300 - 600 m and has a mean annual rain fall of 350 - 650 mm. the climate is semi-arid warm, sub-tropical winter/monsoon and falls under climax vegetation of dry sub-tropical broad-leaved-thorn mixed forest, agro-ecological region VI (Beg *et al*., 1987). The mean maximum temperature ranges up to 40˚C in May-June, while the mean minimum temperature of 2.2˚ to 4.7˚C occurs during December and January (Fig. 1).

Soils. The area has complex geological history of organic disturbances, erosion and depositional cycles. This has resulted in the formation of mountains and rough broken lands, including coarse loamy to sandy clay loams, brown to reddish brown and excessively drained (Ahmad *et al*., 1998). These soils have been developed *in situ* from underlying rocks, which consist mainly of limestone, cretaceous slates, sandstone and shale. The relief is above 1.52 m steep slopes. Water erosion, aridity and removal of top soil have reduced the productivity of grazing lands.

Rough broken, gravelly coarse loamy to fine loamy, loess, dark yellowish brown and excessively drained soils are wide-spread in the survey area and mainly occur on banks of the major streams and their associated ravines.

These soils occupy sloping to gently sloping, deeply dissected loess plains broken by many intermittent drainage channels. The run-off is high and geological erosion is very active.

Land use. The study area consists of rough broken lands of Pothwar plateau. Dry farming and livestock rearing is the main land-use. Most of the time during the year, quite a large area is kept fallow for wants of rain-fall. Wheat, rapeseed, Mustard and chick pea are the main Rabi crops, while maize, millets and sorghum are the major Kharif crops. Traditional fodder crops like berseem and lucern and guar and sesbania are grown in association with the Rabi and Kharif crops, respectively on the condition of availability of water (Ahmad *et al*., 1998). Un-protected lands are meant for open grazing and fuel wood extraction by the local people (mapping units 1.2 & 2.2). On the other hand the protected areas (flat & hilly), are controlled and managed by the Forest Department (mapping units 1.1 & 2.1).

METHODOLOGY

For conducting quantitative vegetation survey, field map of the area showing soil units (1 & 2) was prepared from agro-ecological units map. With the help of topographic map of the area, protected forest areas were delimited on the field map to indicate separate sub-units for protected (0.1) and un-protected (0.2), (Fig. 2). The number of representative stands selected varied from 2 to 6 depending on the size of sub-unit. Vegetation survey to estimate forage production, was conducted following the previous qualitative and quantitative methods (Ahmad *et al*., 1998). In total, 14 transacts were sampled. Three ring quadrates (0.88 m^2 each) were placed at 6 m intervals (Hussain, 1968) along the direction of each transect, mentioned in the previous study. In this way, a total of 42 ring quadrates were laid out. The edible portion of all the palatable plant species inside the ring quadrat was clipped and fresh weight taken. Clipped samples were air dried for 15 days and dry weight was assessed to determine dry matter forage production (kg/ha).

Analysis of variance among the transects and between the protected and un-protected of each ecological unit, was done, for comparison of forage production. Coefficient of variance of each ecological unit was also determined. Available forage was calculated on the basis of 50% of the total as use factor. Carrying capacity in Animal Units per Year (AUY) per hectare was calculated taking into account that a cow consumes 9 kg of dry matter daily.

RESULTS AND DISCUSSION

Table I depicts the nature of plant communities in various ecological units. Importance values and Summed Dominance Ratios (SDR) for the respective ecological units were calculated after Chul and Moody (1983). Table II

Fig. 1. Climatic diagram of Attock area

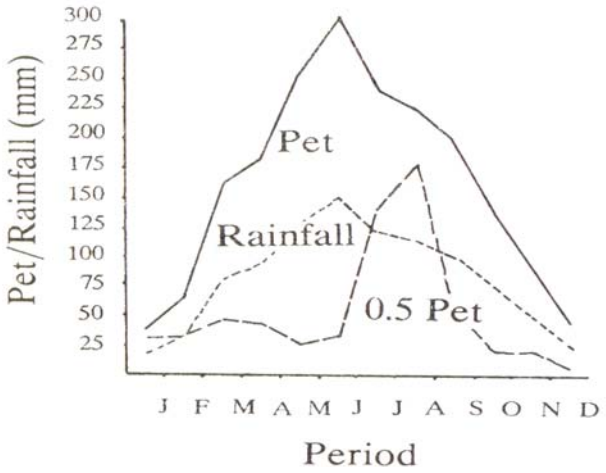

Fig. 2. Vegetation and land use map of southern Attock

MAPPING UNIT	PLANT COMMUNITY
1.1	Chrysopogon montanus – Dodonaea viscosa Semi-arid, gravelly, loamy, protected grass-shrubland association
1.11	Chrysopogon montanus – Dodonaea viscosa Northern Aspect, grass–shrubland sub-association
1.12	Chrysopogon montanus – Heeropogon contortus Southern Aspect, grassland sub-association
1.2	Heteropogon contortus – Dichanthium annulatum Semi-Arid, gravelly, loamy, unprotected grassland association
1.21	Heteropogon contortus – Dichanthium annulatum Northern Aspect, grassland sub-association
1.22	Heteropogon contortus – Dichanthium annulatum Southern Aspect, grassland sub-association
2.1	Acacia modesta – Acacia nilotica Semi-Arid, rough broken loess, unprotected woodland association
2.2	Eleusine compressa – Eragrostris poaeoides Semi-Arid, rough broken loess, protected woodland association
3	Cultivated Cropped Area

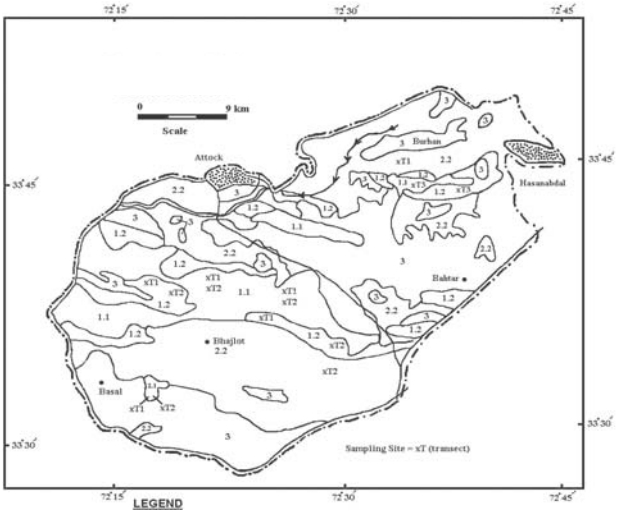

Table I. Importance value and nature of plant communities in different ecological units

Ecological unit	Plant community	Grand average of the transects			Importance value
		Relative cover %	Relative density %	Relative frequency%	
1.1 Protected	*Chry sopogon montanus-*	21.3	37.1	19.7	78.2
	Dodonaea viscosa	14.7	11.0	12.5	38.2
1.11 Northern aspect	*Chry sopogon montanus-*	20.1	43.9	17.6	81.6
	Dodonaea viscosa	24.0	11.2	17.4	52.6
1.12 Southern aspect	*Chry sopogon montanus-*	22.5	30.4	21.9	77.7
	Heteropogon contortus	10.3	14.5	13.9	38.7
1.2 Unprotected	*Heteropogon contortus-*	20.8	28.0	16.8	65.6
	Dichanthium annulatum	11.3	18.5	10.2	40.0
1.21 Northern aspect	*Heteropogon contortus-*	26.8	37.5	18.7	83.1
	Dichanthium annulatum	14.1	25.4	9.2	48.6
1.22 Southern aspect	*Heteropogon contortus-*	14.8	18.5	14.9	48.3
	Dichanthium annulatum	8.5	11.6	11.3	31.5
2.1 Protected	*Acacia modesta-*	33.1	16.6	14.1	63.8
	Acacia nilotica	26.3	13.5	13.4	53.2
2.2 Unprotected	*Eleusine compressa-*	48.7	80.4	33.3	162.4
	Eragrostis poaeoides	6.3	8.5	14.1	28.9

indicates the protected and un-protected areas of each ecological unit. It shows transect/aspect wise average forage production. Analysis of variance between the aspects and transects of each protected and un-protected ecological sub-units revealed non-significant differences. Northern and southern aspects of protected mountainous ecological unit 1 showed 2531.5 and 1826.1 kg/ha of dry matter forage yield, respectively. On the other hand, the forage production of northern and southern aspects of un-protected hills was 1058.1 and 1007.1 kg/ha, respectively. Protected and un-protected transects of rough broken lands of ecological unit 2 showed non-significant results, with minor differences in forage production (Table II). Protected northern aspect gave 705.4 kg/ha more production as compared to protected southern aspect. It may be attributed to higher moisture regime on the northern aspect.

Northern and southern aspects of un-protected mountainous area behaved similarly in forage production, because of un-protection from over-grazing. In ecological unit 2, protected area gave 1138.7 and 1320.3 kg/ha more forage production, respectively compared to their respective un-protected transects.

However, the results between both the protected and un-protected ecological units showed significant differences (Table III). Analysis of variance between protected and un-protected areas of each ecological unit showed average forage production of 2178.8 and 1033.9 kg/ha and 2745.0 and 1515.5 kg/ha, respectively.

The significant differences were real due to protection and un-protection vs. no grazing. Total forage production (herbage & browse) in protected and un-protected areas of the two ecological units is indicated in Fig. 3.

Rangeland development potential. Qualitative and quantitative estimation of forage production in protected forest areas showed that un-protected and open to grazing lands can be reclaimed simply by protection from grazing and introducing improved grazing management systems. Protected ecological units 1.1 and 2.1 (Table IV) depicted carrying capacity of 0.41 and 0.52 AUY/ha as compared to un-protected ecological units (1.2 & 2.2), which was 0.20 and 0.29 AUY/ha, respectively. An area of 13230 ha of un-protected open grazing land in ecological unit 1 and 42210

Fig. 3. Forage production in ecological units of southern Attock

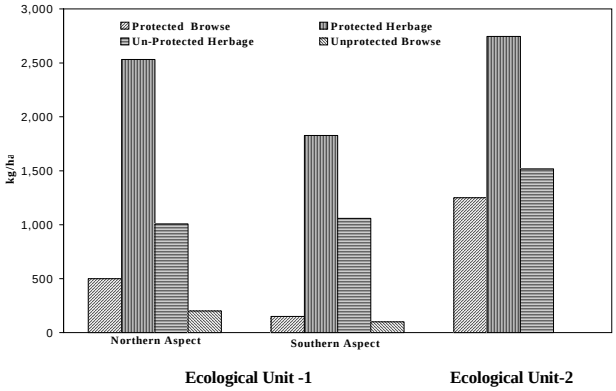

Table II. Transect/aspectwise average forage production (Kg/ha) dry matter as total of herbage and browse

Ecological unit 1			Ecological unit 2		
Transect/Aspect	Protected	Un-protected	Transect	Protected	Un-protected
T / Northern	2531.5	1058.6	T1	2695.3	1556.6
T / Sorthern	1826.1	1007.1	T2	2794.6	1474.3
F. Value		1.16*			0.001*

* Non-Significant

Table III. Average forage production (Kg/ha) dry matter as total of herbage and browse (Grand average of the transects), significant at 5% level

Ecological Units	Ecological Unit 1	Ecological Unit 2
Protected	2178.8 **	2745 **
Unprotected	1033.9 **	1515.5 **
F-Value	14.21	24.09
C.V	32.79%	20.37%

** Highly Significant

Table IV. Carrying capacity (A.U.Y) in different ecological units of southern Attock

Ecological mapping unit	Extent of area (ha)	Avg. Dry matter forage production (kg/ha) spring-summer period 273 days	Avg. Annual forage production (kg/ha) including winter period 365 days	Available forage (kg/ha)	Carrying capacity AUY/ha	Carrying capacity of the given area	Development potential of un-protected area
1.1	17910	2178.8	2723.5	1361.7	0.41	7343	-
1.2	13230	1033.9	1292.4	646.2	0.2	2646	105%
2.1	430	2745	3431.2	1715.6	0.52	223	-
2.2	42210	1515.5	1894.4	947.2	0.29	12240	79.30%
3			Cultivated Area				

ha of un-protected ecological unit 2, (Vegetation & land use map, Fig. 2) showed 105% and 79.3% development and production potential, respectively in terms of carrying capacity (Animal Unit per Year per hectare).

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