EVALUATION OF TWENTY SEVEN YEAR BASTARGI EXCLOSURE IN ZIARAT JUNIPER FORESTS OF PAKISTAN

by

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Summary. *A 16 hectare exclosure was established in Ziarat Juniper forests in 1949 to find out the effects of protection on the vegetation and soil characteristics. In 1977, twenty seven years after its establishment, eighty randomly selected one square meter plots were studied for forage production, frequency and surface features inside the exclosure and equal number outside. Tree cover; forage yield and frequency of grasses, and frequency of more palatable shrubs was higher in the exclosure than in the open. All the species recorded in the grazed area were also found inside the exclosure, but with lower forage yield and frequency, while some new more palatable species got established inside the protected area.*

The area. The study area (Bastargi) is situated in the Himalayan dry temperate forest zone (Champion et al, 1965) about 2 km east of Ziarat, latitude 30° 24′ N, longitude 64° 44′ E, elevation about 2500 m, average annual rainfall about 25 cm. Climate data recorded from August 1976 to April 1977 are as follows:

Month	Temperature		Rainfall	No. of rainy days	Snowfall depth	No. of snowy days	Mean relative humidity
	Mean Max. (C°)	Mean Min. (C°)	(mm)		(cm)		(%)
August, 1976	26.1	11.2	5.33	3	—	—	31.7
September	22.5	7.9	14.40	9	—	—	30.0
October	21.8	2.7	0.51	1	—	—	25.0
November	15.2	3.3	—	—	—	—	22.0
December	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
January, 1977	6.3	9.5	—	—	93	6	81.0
February	11.0	4.2	—	—	—	—	42.0
March	15.3	1.9	1.53	3	—	—	27.0
April	18.0	4.8	12.70	8	—	—	38.0

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The soils in the exclosure (16 hectares, established in 1949) are calcareous clay-loams mainly formed on soft shale. The area under or near woody plants is covered with litter, the rest with stone and pebble. The soils are poorly developed and have shallow profiles. About 10 to 30% by volume and 10-80% by weight of the soils is comprised of stones. The average slope of the study area is 8%.

The following species contribute mainly to the local plant cover:

Trees: *Juniperus excelsa*

Shrubs: *Acantholimon* near *stocksii*, *Acantholimon polystachyum*, *Acanthohyllum grandiflorum*, *Artemisia maritima*, *Berberis baluchistanica*, *Caragana ambigua*, *Daphne oleoides*, *Ephedra procera*, *Iris songarica*, *Lonicera hypoleuca*, *Onebrychis cornuta*, *Perowskia abrotanoides*, *Prunus eburnea*, *Spiraea brahuica*.

Forbs: *Aster altaicus*, *Astragalus* sp., *Cousinia multiloba*, *Cousinia* sp., *Cousinia racemosa*, *Eremurus persicus*, *Euphorbia caeladenia*, *Euphorbia pigmaea*, *Caillonia eriantha*, *Hertia intermedia*, *Onobrychis* sp., *Onosma dischroanthum*, *Pegolettia senegalensis*, *Polygonum polyonemoidea*, *Rubia infundibularis*, *Scutellaria multicaulis*, *Thymus serpyllum*, *Viola stocksii*.

Grasses: *Agropyron cristatum*, *Aristida adscensionis*, *Dichanthium annulatum*, *Eragrostis poaeoides*, *Lolium perenne*, *Melica persica*, *Oryzopsis aequiglumis*, *Phacelurus speciosus*, *Stipa* near *splendens*, *Stipa szowitsiana*.

The exclosure is situated in an area with a long history of heavy continuous grazing but since 1949 no grazing by large animals has occurred within the exlcosure while an ever-increasing number of livestock mostly goats, sheep, camels and donkeys have continued to graze the area outside the exclosure. Small mammals have not been excluded from the exclosure, of which the pika are particularly noticeable.

Within the exclosure 2 stands were delineated based on the visual homogeneity of vegetation and topography. The present study is confined only to the gently sloping stand in the eastern part of the exclosure.

Methods: In May 1977 the 10 hectare area inside the exclosure was traversed by four line transects, two running along the diagonals of the stand and two joining the mid-points of its opposite sides. On each transect 20 one m^2 plots were randomly selected throughout its length. A similar area of 9.5 hectare having similar elevation varying from 2525 to 2560 metres and similar slope of 8 percent and vegetation type was selected outside the exclosure.

The quadrats were classified into 6 groups depending upon the situation of the plot under, near or away from the woody plants. The following number of quadrats were taken:

Group	Number of plots	
	Inside	Outside
A. *Under or near woody plants*		
Under the trees	14	10
On fresh humus of the trees but not under their canopy	5	2
Under the canopy or on fresh humus of the shrubs	6	—
B. *Away from woody plants*		
Rock cover upto 80%	15	12
Rock cover from 81-90%	36	15
Rock cover 91-100%	4	41
	80	80

All the palatable grass and forb species within each plot were clipped 1 cm above ground level with hand shears while only the current year herbage growth of the shrubs within reach of the livestock was clipped. The species completely avoided by livestock were not clipped. The clipped material was then air-dried and weighed (Hussain, 1968). The airdry weights (gm/m^2) were multiplied by 10 to get the forage production of each species in kg/ha. The surface characteristics for each plot were determined by adjustable decimal collapsible quadrat (Khan, 1974) recording the % area covered by the bases of all plant species, litter, cryptogams, rock pavement, and bare soil, Rock sizes were classified into the three diameter classes (cm): upto 5, 6-15, 16-60 (Siemens et al, 1976). The frequency of each species was also recorded separately for desirable, intermediate and undesirable species (Hussain and French, 1962).

Results and discussion: The good forage shrubs like *Prunus eburnea*, *Lonicera hypoleuca* and *Berberis baluchistanica* are found only inside the exclosure. These shrubs have been completely exterminated with overbrowsing and uprooting for firewood in the open area.

Effect of closure on total forage production: The average total production kg/ha is 585 inside the exclosure as against 83 outside.

Forage production kg/ha

Location	Inside		Outside	
	Range	Average	Range	Average
Under the tree canopy	140—1350	608	0—33	7
On fresh humus of the tree but not under their canopy	470—1470	1026	10—22	16
Under the canopy or on fresh humus of the shrubs	80—670	443	No shrubs present	
Away from woody plants, rock cover upto 80%	205—1380	648	33—345	218
Away from woody plants, rock cover from 81-90%	85—905	320	25—305	115
Away from woody plants, rock cover from 91-100%	350—990	538	14—136	51
Average		585		83

Inside the exclosure the total forage production in the plots under or near woody plants is generally higher than that away from the woody plants, outside, the reverse is the case. This may be due to sheep and goats resting in shade during mid-day.

The contribution of different life forms to total forage production in different location groups is as follows:

Location	Grasses		Forbs		Shrubs	
	Inside	Outside	Inside	Outside	Inside	Outside
Under the tree canopy	64	42	2	41*	34	17
On fresh humus of trees but not under their canopy	89	62	2	40*	9*	—
Under the canopy or on fresh humus of shrubs	72	No plot	4	No plot	23	No plot
Away from woody plants, rock cover upto 80%	87*	4	3	32*	10	64*
Away from woody plants, rock cover 81-90%	95*	6	4	81*	1	13*
Away from woody plants, rock cover 91-100%	90*	22	10	46	—	32*
Average	86*	12	3	49*	11	39

* Significant — 0.05 level
** Highly singificant — 0.01 level

The grasses form a higher part of the total forage yield inside the exclosure than of that outside it.

The contribution of grasses and forbs to the total forage production is significantly higher in all the groups inside the exclosure., Inside the exclosure, shrubs contribute more to forage production under or near woody plants; outside the exclosure the contribution of shrubs is more when they grow away from the woody plants.

Effect of closure on total frequency of life forms: The frequency of different life forms in different areas is not significantly affected except in case of areas under the trees and on the fresh humus of trees not under the canopy of tree where shrubs increase on protection:

Group	Grasses		Forbs		Shrubs	
	Inside	Outside	Inside	Outside	Inside	Outside
Under the trees	100	40	36	20	71*	20
On fresh humus of the trees but not under their canopy	100	100	60	100	80*	—
Under the canopy or on fresh humus of the shrubs	100	No plot	50	No plot	100	No plot
Away from woody plants, rock cover upto 80%	100	92	60	100	73	100
Away from woody plants, rock cover from 81-90%	100	67	69	100	61	87
Away from woody plants, rock cover from 91-100%	100	93	75	90	75	68
Average	100	83	60	86	63	74

Effect of closure on palatability of vegetation: The contribution of different palatability classes to total forage production in different groups is as follows:

Group	Desirable		Intermediate		Undesirable	
	Inside	Outside	Inside	Outside	Inside	Outside
Under the trees	19*	—	78	29	2	71*
On fresh humus of the trees but not under their canopy	4*	—	95	11	1	89*
Under the canopy or on fresh humus of the shrubs	14	No plot	83	No plot	4	No plot
Away from woody plants, rock cover upto 80%	5	1	93	64	2	35*
Away from woody plants, rock cover from 81-90%	4	—	93*	13*	3	87*
Away from woody plants, rock cover from 91-100%	1	0.2	90	33	10	7
Average	7	0.1	9	40	3	59*

*Significant

**Highly significant

No desirable species has been recorded in plots under or near the woody plants outside the exclosure. The contribution of desirable species is higher in all other groups in the protected area than those in the grazed area. The contribution of intermediate species is also higher in all the groups in the protected plots than in the plots open to grazing.

The frequency of different palatability classes in various groups is given below:

Group	Desirable		Intermediate		Undesirable	
	Inside	Outside	Inside	Outside	Inside	Outside
Under the tree	57*	—	100*	20	43	40
On fresh humus of the trees but not under the canopy	40*	—	100	50	60	100
Under the canopy or on fresh humus of the shrubs	83	No plot	100	No plot	67	No plot
Away from woody plants, rock cover upto 80%	40	17	100	83	73	100
Away from woody plants, rock cover from 81-90%	42*	—	100	53	78	100
Away from woody plants, rock cover from 91-100%	25*	2	100	46	75	100
Average	46*	4	100	51	69	93

The frequency of desirable plants has significantly increased in all the groups on closure, whereas an appreciable increase in intermediate species is noticed only under trees.

Effect of closure on individual plant species: *Artemisia maritima* produced maximum forage weight of 39.4 kg/ha in the grazed areas. The second highest producer is *Thymus serpyllum* producing 38.3 kg/ha followed by *Eragrostis poaeoides* (8.2 kg/ha). *Artemisia maritima* is intermediate and the other two species are undesirable from the forage point of view. Whereas in the protected area maximum production of 4308 kg/ha is recorded from *Stipa szowitsiana* and second highest (48.3 kg/ha) from *Ephedra procera*. *Oryzopsis aequiglumis* with 37.6 kg/ha ranks third. *Oryzopsis* is desirable while the other two are intermediate forage species.

In the unprotected area *Eragrostis poaeoides* is the most frequent species being recorded in 74% of the plots. *Euphorbia caeladenia* in 67.5% plots and *Thymus serpyllum* in 42.5% plots. These are all undesirable forage species. Against this inside the protected exclosure *Stipa szowitsiana* is present in all the plots. *Pegolettia senegalensis* and *Onobryohis* sp, are the second most frequent species with 26.3% frequency. Out of these *Stipa szowitsiana* and *Pegolettia senegalensis* are intermediate and only *Onobrychis* sp. is undesirable forage species.

Oryzopsis acquiglumis, *Lolium perenne*, *Agropyron cristatum*, *Stipa* near *splendens*, *Berberis baluchistanica*, *Lonicera hypoleuca*, *Ephedra procera* and *Rubia infundibularis* recorded in the protected area have not been recorded in the open area. All the species

recorded outside the exclosure have also been recorded inside. This shows that none of the species found before protection has yet been completely eliminated though some new species have appeared on protection.

Effect of closure on surface characteristics: Surface characteristics viz., plant base cover, litter cover, rock cover and bare soil did not show any significant response to closure.

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