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System approach to grazing in desert ecosystems: A case study in Saudi Arabia

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SUMMARY – This paper highlights a system approach to grazing in a desert ecosystem used by the Range and Animal Development Research in the northern region of the Kingdom of Saudi Arabia. Various factors affecting plant and animal production in a high potential desert system (wadi bottom) are discussed. The use of cultural treatments for increased forage production, the effect of protection and flock management for reduced grazing pressure are among the different aspects studied for the integrated management of rangeland resources, which have considerable implication in combating desertification. A summary of major results from the various research topics is reported.

Keywords: Cultural treatment, protection, native species, grazing management.

RESUME – *"Approche systémique du pâturage dans les écosystèmes désertiques : étude de cas en Arabie Saoudite". Ce document met en lumière une approche systémique de pâturage dans un écosystème désertique utilisé par la recherche pour le développement des pâturages et des animaux dans la région nord du Royaume d'Arabie Saoudite. Divers facteurs influant sur la production végétale et animale dans un système désertique à fort potentiel (fond de l'oued) sont discutés. L'utilisation du traitement cultural pour la production fourragère accrue, les effets de la protection, la gestion des troupeaux afin de réduire la pression sur le pâturage, sont parmi les différents aspects étudiés pour la gestion intégrée des parcours, ce qui a une grande implication sur la lutte contre la désertification. Un résumé des principaux résultats des différents thèmes de recherche est présenté.*

Mots-clés : *Traitement de la culture, protection, espèces indigènes, gestion du pâturage.*

Introduction

Saudi Arabia is an extremely arid country. Forage production is therefore very low with considerable year to year variability and because of its low potential. Bedouins kept small stocks of predominantly hardy camels for transport and milk production. Increased revenue from oil however, resulted in a society with high demand for red meat. The government therefore, encouraged increase of livestock population through a system of subsidies. This changed range livestock production from small subsistence holdings to highly mechanized large commercial herds. The result has been deterioration of rangelands. The government of Saudi Arabia started rehabilitation and conservation programmes through two major interventions of: (i) establishing large but unfenced protected area and (ii) establishing large enclosures as research stations. This paper highlights system approach to improvement and management of rangelands conducted in Northern Saudi Arabia under Unilateral Trust Fund agreement between the Kingdom of Arabia and the Food and Agriculture Organization of the United Nations. The programs and results are conveniently discussed in this paper under range improvement and plant/animal interaction.

Range improvement

Several trials all aimed at the improvement of vegetation for range-livestock production using principles of restoration ecology were carried out. Techniques used include protection as tool for assisted regeneration, and use of cultural treatments Improvement by protection.

Monitoring of the response of vegetation over a six year period have shown substantial changes at

both protected and heavily grazed sites. The response has been one of considerable improvement in range condition in the protected area and continuous deterioration of the grazed area. The vegetation in the protected areas has shown increased density of the more desirable species of *Salsola vermiculata* and *Atriplex leucoclada* and disappearance of species such as *Achillea fragrantissima and Astragalus spinosus*. Undesirable species were on the increase under uncontrolled grazing (Table 1).

Table 1. Changes in vegetation composition over six years in protected and grazed area

Species	% Composition			
	Starting year		Year six	
	Protected	Grazed	Protected	Grazed
Achillea fragrantissima	33.0	21.0	01.0	64.0
Anabasis setifera	00.0	00.0	24.0	00.0
Artemisia herba alba	00.0	04.0	03.0	04.0
Astragalus spinosus	33.0	05.0	00.0	00.0
Atriplex leucoclada	18.0	00.0	31.0	00.0
Fagonia glutinosa	00.0	54.0	00.0	23.0
Haloxylon salicornicum	08.0	06.0	02.0	09.0
Salsola vermiculata	07.0	10.0	39.0	00.0

Cultural treatment

Soils of the major rangelands have very poor infiltration due to surface crusting with poor vegetation. Mechanical land treatments of contour furrowing and pitting were compared in areas receiving annual rainfall of less than 100 millimeters. Results from the trial indicated that furrowing and pitting increased water infiltration and herbage production and reduced soil bulk density (Table 2). Results are similar to previous studies which indicated that mechanical treatments generally resulted in higher water infiltration (Wight *et al.,* 1981) and higher herbage production both in quantity and quality (Valentine, 1980)

Table 2. Forage yield, bulk density, soil moisture and depth of infiltration in contour furrow and pitted and control treatments

	Contour furrows	Pits	Control
Forage yield (dry matter/ha)	293.00 a	72.00 b	0.000 c
Bulk density	1.29	1.32	1.59
Depth of infiltration (cm)	28.80 a	27.10 a	12.00 b
Moisture content (cm^3H^2O/cm^3 soil)	0.17 a	0.14a	0.07 a

Plant and animal interaction

Several experiments involving plant-animal interaction were conducted in different years using a breeding flock of sheep. Seasonal dry matter utilization was determined from paired fenced and grazed plots using before and after grazing clippings. Year to year variability in dry matter production was found to be very high and was more pronounced in the dry matter production from annuals (Table 3). Though year to year variability of the production of annual plant was high yet they constituted 76% of the total dry matter production ranging from 50% to 90%. This high variability in production has considerable implication in management and particularly in stocking rates.

Table 3. Dry matter in kilograms per hectare and millimeters of rainfall (1984-1993)

Years											Average	CV %
	84	85	86	87	88	89	90	91	92	93		
Total	182	306	474	1269	3125	622	45	415	40	30	650.8	145
Annuals	156	156	253	1067	2752	328	10	214	10	00	494.2	172
Perennials	26	150	221	202	373	294	35	201	30	30	156.2	79
Rain(mm)	44	75	42	122	40	12	29	32	32	39	46.7	

Response of animals to climatic variability

The variability of the quantity and the quality of available forage was reflected in the performance of the animals. Lambs born in November to January compared for three consecutive years (1988-1990) in none supplemented range have shown similar birth weight and growth for the first 30 days of suckling for all the years. However, lamb growth in 1988 was considerably higher than 1989 and 1990 (Fig. 1). The large difference in weight of lamb growth was attributed to the large difference in dry matter production and particularly dry matter yield of nutrient rich annuals. Therefore, in normal and below normal years lamb growth was poor and off-range marketing of lambs was found to hold lambs in the range between 3 to 6 months after weaning to reach market weight thus putting more pressure on the range.

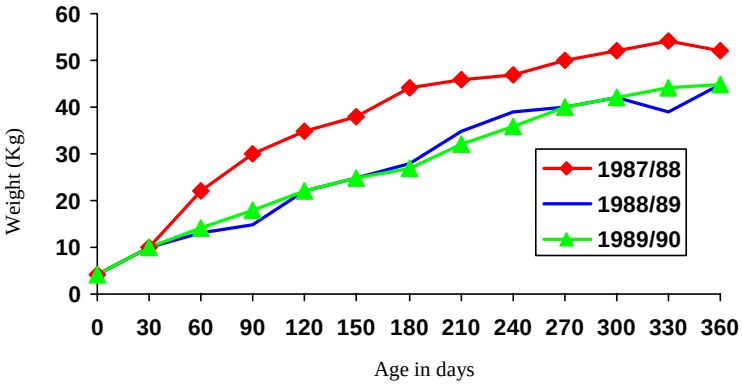

Fig. 1. Weight changes of range base lambs from birth to 360 days for 3 years.

Ewes grazing the range lost 9.5, 11.73 and 12.49 kg (from birth to weaning of their lambs) amounting to 18, 22 and 23 percent of their body weight in the years 1987/88, 1988/89 and 1989/90 respectively (Table 4). Compensatory weight gain from weaning to mating was related to grazable forage quantity from green annuals and perennials during spring and summer. Growth of range-base animals will therefore be mainly influenced by the quantity and length of availability of annuals in the growing season.

Table 4. Weight changes of suckling ewes from birth to mating for a period of three years

	1987/88	SD	1988/89	SD	1989/90	SD
Birth weight (kg)	52.50	7.36	53.95	5.66	54.04	6.11
Weaning weight (kg)	42.94	7.29	42.22	3.54	41.55	4.55
Mating weight (kg)	52.85	7.45	49.75	4.46	47.96	5.23

Impact of deferred grazing on plant and animal performance

Response of vegetation in two pastures of 100 hectares each stocked with sheep at two separate grazing periods were monitored. Cover measurement at three different periods, for early and late grazed pastures is given in Table 5. The relatively low reduction in cover of perennial plants and the disappearance of annuals is an indication that annuals constitute the bulk of the forage for grazing animals when they are present.

Weight changes of the grazing flock are given in Fig. 2. In the early grazed pasture, adult ewes and replacement lambs respectively gained 136 and 141 grams per day in May when green annuals were available. The average daily gain progressively declined until July for both adults and lambs. However, when the sheep were placed in the rested pasture in August the average daily gain again increased for both classes of animals. The relatively high gain of the grazing flock in August compared to the drop in weight in June-July is attributed to the availability of the annuals in the rested pasture. In both pastures sheep performance was related to the availability of annuals. Mirreh *et al*. (1990) and Mirreh *et al.* (1991) reported the progressive decline in shrub quality and the progressive decline in animal performance under free selection and free access grazing. It was reported that animals can be maintained without supplement in this kind of range up to the end of October (Mirreh *et al.,* 1990 and Mirreh *et al.,* 1991) in an average year of rainfall.

Table 5. Percentage vegetation-cover in early and late grazed similar pastures

Species	Early grazed pastures (May 6 to July 31)			Late grazed pastures (Aug. 1 to Nov. 10)		
	May	Jul.	Oct.	May	Jul.	Oct.
Salsola vermiculata	13.33	11.46	10.94	15.64	15.64	11.69
Anabasis setifera	3.93	2.16	2.44	3.04	1.56	2.24
Halothamnus iraqensis	1.06	1.29	0.81	0.33	0.65	0.54
Achillea fragrantissima	0.01	0.70	0.60	0.66	0.01	0.00
Atriplex leucoclada	0.53	0.10	0.44	0.00	1.89	0.16
Haloxylon salicornicum	0.75	0.52	0.87	2.02	3.07	1.65
Artemisia herba alba	1.06	0.87	0.81	1.40	1.46	1.10
Astragalus spinosus	0.21	0.16	0.25	0.00	0.00	0.00
Annual species	40.10	0.00	0.00	35.30	21.18	0.00
Total vegetation	61.42	17.26	17.16	58.39	45.46	17.38
Total perennials	21.32	17.26	17.16	23.09	24.28	17.38

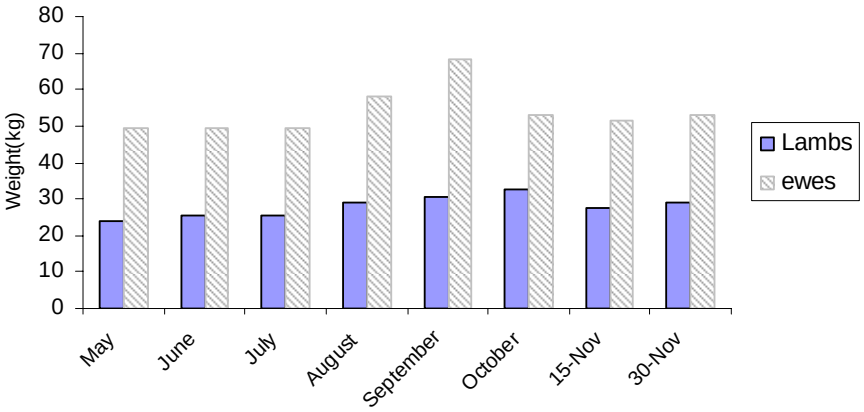

Fig. 2. Weight changes of lambs and adult ewes in early and late grazed pastures.

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