Forage Preferences of Livestock in the Arid Lands of Northern Kenya

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Abstract

The desirability of forage plants by livestock or wildlife is an important consideration in evaluating suitability of the range for grazing. This desirability may also in some cases be used in determining range condition. In many range types periodic determination of plant species composition provides the best indication of long-term trends. Evaluation of the effects of grazing on range flora usually requires that the vegetation be assigned to significant groups. This work represents the first attempt to make this kind of classification for the arid zone of northern Kenya in the study area of the UNESCO Integrated Project in Arid Lands (IPAL). It was required for the preparation of grazing plans for the largely nomadic pastoralists there. Preferences for 250 plant species have been assessed for camels, sheep, goats, and cattle. They are based on the best information presently available, and forms our basis for the classification of range condition for 147 range types in the study area.

The arid lands of Kenya, which cover over 75% of that country, are being seriously degraded as a result of increased pressures from human livestock populations, periodic droughts, and an imbalance between modern and traditional pastoral practices. The productivity of the range has been so reduced that pastoralists are under constant threat of famine. The Integrated Project on Arid Lands (IPAL), of which this work is part, was established by UNESCO to reverse this degradation.

Research on the plant species preferred by livestock in Kenya, particularly in the arid north, has been limited. Since the establishment of the IPAL program in 1976, the published vegetational work has consisted of an annotated vegetation map (Herlocker 1979a), problems concerning the status of montane and other forests (Synott 1979a,b; Herlocker 1979b), an annotated check-list of the plants of Mount Kulal, Kenya (Hepper et al. 1981), feeding observations of camels, cattle, sheep, and goats (Field 1978, 1979; Kayongo-Male and Field 1981; Lewis 1977) and herb-layer productivity in relation to rainfall (Herlocker and Dolan 1980a, 1980b; Walther and Herlocker 1980). Work on woodland availability, productivity and exploitation has also been reported (Lusigi 1981).

The importance of forage plants for both livestock and wildlife is determined by their availability, palatability, and nutritive value. A combination of various levels of these 3 factors should be considered in the condition rating of a particular range site. In more productive rangelands and pastures in Kenya, work has proceeded from determining the availability of forage species to analysis of the nutritive value of preferred forage species (Dougall) and Bogdan 1951a,b; Dougall et al. 1964; Field 1975; Gwynne 1969; Tærum 1970). In the less productive rangelands in the arid zone, information available on the nutritive value of indigenous forage species and their preference for livestock is still very scanty except for a generalized review of browse (Lamprey et al. 1980). The objective of this study was to classify the preference of livestock for

all major forage plants in the area so that range condition and trend can be assessed.

Study Area

The IPAL study area has been described in the many technical reports published by the project (Lusigi 1981, 1983). It covers an area of 23,000 km² in the Marsabit District of Northern Kenya, situated between 5 major mountain ranges: Hurri Hills, Marsabit Mountain, Ndoto mountain range, Mount Kulal, and four important water catchment systems in this arid environment (Herlocker 1979).

The vegetation cover of the area is varied. There are small montane forests at the peak of the mountains, mist forests on hills, and perennial grasslands on lower slopes. In the lowlands are groundwater forests, semideciduous woodlands, deciduous woodlands, semiarid to arid bushlands and shrublands, arid dwarf shrublands, annual grasslands, and barren lands. With exception of the mountains which receive about 700 mm average annual rainfall, the rest of the area receives about 200 mm. The rainfall is highly erratic.

The area is inhabited by nomadic and seminomadic tribes, which include the Rendille, Samburu, Gabbra, Borana, and Turkana. Apart from minimal agricultural activities on Marsabit mountain, the entire nomadic population derives its livelihood from livestock. The major livestock are camels, sheep, goats, and cattle.

The main species of wild grazing herbivores in the study area are Beisa oryx (*Oryx beisa beisa*) and Grevy's zebra (*Equus grevyi*). Other wild herbivores include dik dik (*Rhynchotragus guentheri*), genoruk (*Litocranius walleri*), Grant's gazelle (*Gazella granti*), reticulated giraffe (*Giraffa camelopardalis reticulata*), rhinoceros (*Diceros bicornis*), and elephant (*Loxodonta africana*). Other animals include lion (*Panthera leo*), leopard (*Panthera pardus*), and cheetah (*Acinonyx jubatus*).

Numerically, sheep and goats are most abundant, followed by cattle and camels. The latest aerial survey of the study area estimated 287,040 sheep and goats, 56,810 cattle, 41,400 camels, 1,150 donkeys, 1,840 oryxes, 1,380 zebras, 1,610 giraffes, 3,600 Grant's gazelles, 1,150 gerenuks, and 2,070 ostriches, a total of just under 400,000 animals (Lusigi 1981). The livestock in the study area (excluding donkeys) comprises about 44% of the total livestock estimated for the entire Marsabit District.

Materials and Methods

Preferences of wild ungulates for various plants have been discussed by Talbot (1962), Stewart (1966), and Field (1968). They consist mainly of direct feeding observations of plant species actually ingested by the particular animal species, examination of diet samples collected through oesophageal and rumen fistulas, analyses of stomach contents by cropping animals, and microhistological analyses of fecal material.

The method most commonly used by IPAL livestock scientists has been the direct observation of plants actually eaten. This method is improved by determining the period of time an animal spends feeding on a particular plant species (Field 1978). Data have been collected in various parts of the study area both in the dry and rainy season. The desirability of a plant species is best determined

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The authors wish to acknowledge contributions made to this study by all IPAL Scientists and Field Support Staff.

Manuscript accepted December 15, 1983.

during the rainy season, when plants are at optimal growth stages. The desirability of a species in the dry season largely reflects its availability (Field 1968). Data obtained from the above observations are supplemented by interviews with herdsman who have fairly accurate knowledge of plants eaten by their livestock. Analyses done on fecal material of cattle (Kayongo-Male and Field 1981) and goats (Said 1980) were incorporated into this study.

This paper is a synthesis of available data in published and unpublished articles, and interviews with local people in the IPAL study area.

Food preferences have been grouped into 4 categories—Very Desirable (VD), Desirable (D), Intermediate (I), and Undesirable (U). Very Desirable plants were those observed and reported to be eaten every time an animal encountered them. Desirable plants were those constituting 80% of the animal's diet (Kayongo-Male and Field 1983) and, together with the very desirables, accounted for 80% of the animal's feeding time. Intermediate species were those comprising the remaining 20% of the animal's diet and feeding time, but this category also includes those plants known to be eaten only when there was little or no alternative forage. Undesirables were those with no observed utilization. The last category includes toxic and noxious plants. However, a plant species preferred by an animal at a given time may, in some circumstances, prove to be toxic, especially when eaten in large quantities. Others

may be toxic at particular growth stages. Caution must therefore be exercised in interpreting these data, since no attempt is made to give any information on toxicity or nutritive value in terms of chemical composition.

A total of 256 plant species consisting of 80 trees and large shrubs, 34 dwarf shrubs, 22 perennial grasses, 68 herbs, 38 annual grasses and sedges and 14 creepers and climbers were examined.

Results and Discussion

Seasonal Use of Plants

Since rainfall in the IPAL study area is low and temperatures high (Edwards et al. 1979), a large number of annuals and deciduous plant species are present. A fair number of perennial species have also been observed on the study area which are utilized in both the dry and rainy seasons. During the drier parts of the year, annuals may still form an important part of the diet of livestock, in standing dead form or litter. The desirability of a plant species, or its undesirability, may reflect its availability rather than palatability. For example, the desirability of most *Cadeba* species seems to improve in the dry season for camels; and though *Balanites aegyptiaca* is recorded as undesirable in the wet season for the same livestock species, it is intermediate in the dry season (Table 1), because it remains green long after the desirable species have lost their leaves.

Table 1. Food preference of various livestock species in the Integrated Project on Arid Lands (I.P.A.L.) Study Area in the wet and dry seasons. (VD - Very desirable; D - Desirable; I - Intermediate; U - Undesirable)

Plant Species	Camels		Sheep		Goats		Cattle	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Trees and Large Shrubs								
<i>Acacia brevispica</i>	D	D	U	I	D	D	U	U
<i>Acacia eleior</i>	D	D	U	U	U	I	U	U
<i>Acacia horrida</i>	U	U	U	U	U	U	U	U
<i>Acacia mellifera</i>	I	U	U	D	D	D	U	U
<i>Acacia nubica</i>	U	I	U	U	U	I	U	U
<i>Acacia paolii</i>	I	U	U	U	I	U	U	U
<i>Acacia reficiens</i>	I	U	U	U	I	I	U	U
<i>Acacia senegal</i>	U	U	U	U	D	U	U	U
<i>Acacia seyal var seyal</i>	U	I	U	U	U	I	U	U
<i>Acacia tortilis</i>	D	VD	U	D	I	VD	U	U
<i>Balanites aegyptiaca</i>	U	I	U	U	U	U	U	U
<i>Boscia angustifolia</i>	U	U	U	U	U	U	U	I
<i>Boscia coriacea</i>	U	I	U	U	U	U	U	U
<i>Boscia minimifolia</i>	U	U	U	U	U	U	U	U
<i>Boswellia hildebrandtii</i>	VD	D	U	I	VD	D	U	U
<i>Cadaba farinosa</i>	U	D	U	U	U	D	U	U
<i>Cadaba glandulosa</i>	I	D	U	D	U	D	U	U
<i>Cadaba mirabilis</i>	U	D	U	U	U	I	U	U
<i>Cadaba ruspolti</i>	U	I	U	U	U	U	U	U
<i>Cadaba sp.*</i>	U	I	U	U	D	I	U	U
<i>Cambretun aculeatum</i>	D	D	U	I	D	D	U	U
<i>Commiphora africana</i>	D	U	U	U	D	I	U	U
<i>Commiphora boiviniana</i>	I	U	U	U	I	U	U	U
<i>Commiphora candidula</i>	D	U	U	U	D	U	U	U
<i>Commiphora flaviflora</i>	D	U	U	U	D	U	U	U
<i>Commiphora paolii</i>	I	U	U	U	I	U	U	U
<i>Commiphora P/Y*</i> (Walther et al. 1980)	I	U	U	I	D	I	U	U
<i>Commiphora rostrata</i>	I	U	U	U	I	U	U	U
<i>Commiphora sp. (green bark)*</i>	D	I	U	U	D	I	U	U
<i>Commiphora sp. (red & white bark)*</i>	I	U	U	U	I	I	U	U
<i>Cordia crenata</i>	U	I	U	U	U	I	U	U
<i>Cordia sinensis</i>	D	U	U	U	D	U	U	U
<i>Croton dichogamus</i>	U	U	U	U	U	U	U	U
<i>Dobera glabra</i>	U	U	U	U	U	U	U	U
<i>Euphorbia cuneata</i>	I	U	U	U	D	U	U	U
<i>Grewia bicolor</i>	I	I	U	I	I	I	U	I
<i>Grewia trembensis</i>	D	D	U	U	D	D	I	U
<i>Grewia tenax</i>	I	U	U	U	D	D	U	U
<i>Grewia trichocarpa</i>	I	D	U	U	U	D	U	U

Table 1. Continued.

Plant Species	Camels		Sheep		Goats		Cattle	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
<i>Grewia villosa</i>	D	U	U	U	D	U	U	U
<i>Jatropha dichtar</i>	U	U	U	U	U	U	U	U
<i>Lawsonia inermis</i>	D	D	U	I	D	D	U	U
<i>Lycium europeum</i>	I	U	U	U	U	U	U	U
<i>Maerua crassifolia</i>	U	D	U	U	U	D	U	U
<i>Maerua oblongifolia</i>	D	D	U	U	U	I	U	U
<i>Maytenus senegalensis</i>	U	U	U	U	D	D	U	U
<i>Maringa</i> sp.*	U	U	U	U	U	U	U	U
<i>Opilia campenstris</i>	I	U	U	U	D	I	U	U
<i>Ormocarpum trichocarpum</i>	U	U	U	U	U	U	U	U
<i>Premna resinosa</i>	D	D	U	I	VD	D	U	U
<i>Rennia triphylla</i>	U	U	U	U	U	U	U	U
<i>Salvadora persica</i>	I	D	U	U	U	I	U	U
<i>Securinega virosa</i>	U	U	U	U	U	U	U	U
<i>Sesamothamnus rivaie</i>	U	U	U	U	D	U	U	U
<i>Solanum arundo</i>	U	U	U	U	U	U	U	U
<i>Sterculia stenocarpa</i>	U	U	U	U	U	U	U	U
<i>Terminalis mollis</i>	D	U	U	U	VD	U	U	U
<i>Terminalis orbicularis</i>	I	U	U	U	D	U	U	U
<i>Trema orientalis</i>	I	U	U	U	I	U	U	U
<i>Vangueria linearisepala</i>	U	U	U	U	U	U	U	U
<i>Wrightia demartianiana</i>	U	U	U	U	U	U	U	U
<i>Ziziphus mauritiana</i>	D	D	U	U	U	I	U	U
Shrubs								
<i>Asparagus aethiopicus</i>	I	U	U	U	I	U	U	U
<i>Asparagus buehnerianii</i>	U	I	U	U	U	I	U	U
<i>Asparagus setaceus</i>	I	U	U	U	I	U	U	U
<i>Aspilota mossambicensis</i>	D	U	D	U	D	U	I	U
<i>Blepharispernum fruticosum</i>	U	I	U	U	I	I	U	U
<i>Clerodendrum myricoides</i>	U	U	U	U	U	I	U	U
<i>Cyclocheilon erianthemum</i>	D	U	I	U	VD	U	U	U
<i>Euclea schimperi</i>	U	U	U	U	U	U	U	U
<i>Euphorbia scheffleri</i>	U	U	U	U	U	U	U	U
<i>Hibiscus aponeurus</i>	D	D	U	I	D	D	U	I
<i>Hibiscus</i> sp.*	D	I	I	I	I	I	U	I
<i>Jatropha parvifolia</i>	U	U	U	U	U	U	U	U
<i>Jatropha villosa</i>	U	U	U	U	U	U	U	U
<i>Lippia</i> sp.	I	D	U	U	I	I	U	D
<i>Osyris abyssinica</i>	U	U	U	U	U	U	U	U
<i>Tinnea aethiopica</i>	D	I	U	U	D	I	U	U
<i>Tinnea</i> sp.*	VD	D	U	U	D	D	U	U
<i>Veronia brachycalyx</i>	D	U	I	U	I	U	U	U
Dwarf shrubs								
<i>Acalypha fruticosa</i>	D	D	D	I	D	I	U	D
<i>Aloe</i> sp.*	U	U	U	U	U	U	U	U
<i>Barleria acanthoides</i>	D	I	U	U	D	I	U	I
<i>Barleria eranthemoides</i>	D	D	U	I	D	D	U	I
<i>Barleria proxima</i>	D	D	D	D	D	D	U	U
<i>Barleria</i> sp.*	D	U	D	U	D	U	U	U
<i>Crotalaria fascicularis</i>	U	U	U	U	I	U	U	U
<i>Crotalaria laburnifolia</i>	I	D	I	D	I	D	I	D
<i>Daysphaera prostrata</i>	D	D	U	U	U	I	U	U
<i>Duosperma cremophilum</i>	I	I	U	U	I	I	I	U
<i>Euphorbia heterochroma</i>	U	U	U	U	U	U	U	U
<i>Helinus integrifolia</i>	D	D	U	U	D	D	U	U
<i>Heliotropium albobispidium</i>	D	I	D	I	D	I	U	U
<i>Indigofera cliffordiana</i>	D	U	D	U	D	U	U	U
<i>Indofera spinosa</i>	VD	VD	D	I	VD	I	I	U
<i>Ipomoea kituensis</i>	U	U	U	U	U	U	U	U
<i>Justicia caerulea</i>	VD	D	I	I	VD	D	U	I
<i>Justicia fischeri</i>	D	I	I	U	D	I	U	U
<i>Justicia odora</i>	D	I	I	U	U	I	U	U
<i>Justicia pinguor</i>	D	D	D	D	D	D	U	I
<i>Kleinia kleinioidea</i>	U	U	U	U	U	U	U	U
<i>Lantana rhodesiensis</i>	U	I	U	I	U	I	U	I
<i>Leucas tomentosa</i>	U	U	U	U	U	U	U	U
<i>Ocimum americanum</i>	U	I	U	I	U	I	U	I
<i>Ocimum</i> sp.*	U	I	U	I	U	I	U	I
<i>Ocimum suave</i>	U	I	U	I	U	I	U	I
<i>Plectranthus igniarius</i>	D	D	U	I	D	D	D	I

Table 1. Continued.

Plant Species	Camels		Sheep		Goats		Cattle	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
<i>Salsola dendroides</i>	U	D	U	U	U	I	U	U
<i>Satureja abyssinica</i>	I	D	I	D	I	D	U	D
<i>Seddera hirsuta</i>	U	I	U	U	U	I	U	U
<i>Sericocomopsis hilderbrandtii</i>	D	D	D	I	I	D	U	D
<i>Sericocomopsis pallida</i>	I	D	U	I	I	D	U	I
<i>Solanum</i> sp. (IPAL)*	I	U	U	U	U	U	U	U
<i>Suaeda monoica</i>	U	D	U	U	U	U	U	U
Perennial grasses								
<i>Botheiochloa inseculpta</i>	I	U	VD	D	D	U	VD	D
<i>Brachiaria</i> sp. (Olturot)*	U	I	D	D	I	I	D	D
<i>Brachiaria</i> sp.*	U	U	D	D	I	U	D	D
<i>Cenchrus pennisetiformis</i>	I	U	D	U	U	U	D	U
<i>Chrysopogon plumulosus</i>	U	U	D	D	U	U	D	D
<i>Cynodon dactylon</i>	U	U	D	D	D	I	D	D
<i>Dactyloctenium aegyptium</i>	U	U	D	U	I	U	D	U
<i>Digitaria abyssinica</i>	U	U	D	D	D	D	D	D
<i>Digitaria scalarum</i>	U	U	D	D	D	D	D	D
<i>Hyparrhenia hirta</i>	U	U	D	I	U	U	D	I
<i>Leptochloa abtusifolia</i>	U	U	D	D	D	I	D	D
<i>Sehima nervosum</i>	U	U	D	D	D	D	D	D
<i>Setaria</i> sp.*	U	U	D	D	D	I	D	D
<i>Sporobolus agrostoides</i>	U	I	D	D	I	I	D	D
<i>Sporobolus fimbriatus</i>	U	U	D	D	I	D	D	D
<i>Sporobolus hervolus</i>	U	I	D	I	U	I	D	D
<i>Sporobolus nervosus</i>	U	U	D	D	U	U	D	D
<i>Sporobolus</i> sp. (Maikona)*	U	U	D	D	U	U	D	D
<i>Sporobolus spicatus</i>	U	U	U	D	U	I	U	D
<i>Tetrapogon tenellus</i>	U	U	I	S	U	U	I	D
<i>Themeda triandra</i>	U	U	D	D	D	D	D	D
<i>Tricholaena teneriffae</i>	I	I	D	D	U	I	D	D
Broadleaf herbaceous plants								
<i>Abutilon hirtum</i>	U	U	U	U	U	U	U	U
<i>Abutilon</i> sp.*	U	I	U	I	I	D	I	D
<i>Acalypha indica</i>	U	U	U	U	D	U	U	U
<i>Acalypha racemosa</i>	U	U	D	U	D	U	D	U
<i>Aerva persica</i>	U	U	U	U	U	U	U	U
<i>Barleria argentea</i>	I	I	I	I	I	I	U	U
<i>Becium oboratum</i>	U	U	U	U	U	U	U	U
<i>Bidens incumbens</i>	U	U	U	U	I	U	U	U
<i>Blepharis linearifolia</i>	VD	D	U	U	VD	U	I	U
<i>Cleome allamanii</i>	I	U	I	U	I	U	I	U
<i>Cleome brachycarpa</i>	D	U	I	U	D	U	U	U
<i>Cleome tenella</i>	U	U	U	U	U	U	U	U
<i>Cleome usambarica</i>	D	U	U	U	D	U	I	U
<i>Commelina africana</i>	D	D	VD	VD	D	D	VD	VD
<i>Commelina benghalensis</i>	D	D	VD	VD	D	D	VD	VD
<i>Conyza phrrhopappa</i>	U	U	U	U	U	I	U	I
<i>Conyza stricta</i>	U	U	U	U	U	I	U	I
<i>Crossandra</i> sp.*	U	U	U	U	U	I	U	U
<i>Crotalaria deserticolor</i>	U	U	U	U	U	U	U	U
<i>Crotalaria massaiensis</i>	U	U	D	I	D	I	D	I
<i>Cynoglossum coeruleum</i>	U	U	U	U	U	U	U	U
<i>Digera muricata</i>	U	U	I	U	I	U	U	U
<i>Euphorbia inaequilatera</i>	U	U	D	U	D	U	U	U
<i>Geigeria acaulis</i>	U	U	U	U	U	U	U	U
<i>Gesikia pharnacoides</i>	U	U	D	U	D	U	I	U
<i>Gloriosa superba</i>	U	U	U	U	U	U	U	U
<i>Gynandropsis cleome</i>	U	U	U	U	U	U	U	U
<i>Heliotropium</i> sp.*	I	U	U	U	I	U	U	U
<i>Heliotropium steudneri</i>	U	U	U	U	U	U	U	U
<i>Hermania borannensis</i>	D	U	D	U	D	U	D	U
<i>Hermanis kirkii</i>	U	U	U	U	I	U	U	U
<i>Indigofera brevicalyx</i>	D	U	D	U	D	U	D	U
<i>Indigofera coerulea</i>	VD	VD	D	D	VD	VD	U	I
<i>Indigofera hochsteteri</i>	U	U	U	U	I	U	U	U
<i>Ipomoea cordofana</i>	D	U	I	U	U	U	U	U
<i>Ipomoea erythrocephala</i>	I	I	I	I	I	I	I	I
<i>Ipomoea kotschyana</i>	U	U	U	U	I	U	U	U
<i>Ipomoea</i> sp.*	D	U	D	U	D	U	I	U
<i>Jasminum</i> sp.*	I	U	I	U	I	U	U	U
<i>Justicia diclipteroideis</i>	D	I	I	U	D	I	U	U

<i>Justicia erigua</i>	D	U	I	U	D	U	U	U
<i>Kouhatia caespitosa</i>	U	U	D	U	D	U	U	U
<i>Leucas sp.*</i>	U	U	I	U	I	U	I	U
<i>Leucas urticifolia</i>	U	U	U	U	U	U	U	U
<i>Limeum prastermissum</i>	U	U	U	U	I	U	U	U
<i>Limeum sp.</i>	U	U	U	U	I	U	U	U
<i>Mollugo cerviana</i>	U	U	U	U	U	U	U	U
<i>Monsonia senegalensis</i>	U	U	U	U	U	U	U	U
<i>Ocimum basilicum</i>	U	U	U	U	U	U	U	U
<i>Ocimum sp.*</i>	U	U	U	U	U	U	U	U
<i>Oldenlandia fastigiata</i>	U	U	U	U	I	U	U	U
<i>Oxygonum sinuatum</i>	U	U	I	U	I	U	U	U
<i>Phyllanthus fischeri</i>	U	U	U	U	U	U	U	U
<i>Phyllanthus rotundifolius</i>	U	U	U	U	U	U	U	U
<i>Phyllanthus sp.*</i>	U	U	U	U	U	U	U	U
<i>Plectranthus sylvestris</i>	I	I	I	I	I	I	I	I
<i>Portulaca oleracea</i>	U	U	U	I	U	I	U	U
<i>Portulaca quadrifida</i>	U	U	U	I	U	I	U	U
<i>Pupalia lappacea</i>	U	U	U	I	U	I	U	U
<i>Senecio lyratiripatus</i>	U	U	U	U	U	U	U	U
<i>Sesamum alatum</i>	U	U	U	U	I	U	U	U
<i>Sesamum sp.*</i>	U	U	U	U	U	U	U	U
<i>Solanum dubium</i>	U	U	U	U	U	U	U	U
<i>Stricta sp.*</i>	U	U	U	U	U	U	U	U
<i>Tephrosia emeroides</i>	U	I	U	U	U	I	U	U
<i>Tribulus terrestris</i>	U	U	U	U	I	U	U	U
<i>Vernonia sp.*</i>	D	U	I	U	I	U	U	I
<i>Zygophyllum simplex</i>	U	U	U	U	I	U	U	U
Annual grasses and sedges								
<i>Aristida adscensionis</i>	U	I	I	D	I	D	D	D
<i>Aristida mutabilis</i>	U	D	D	D	I	D	D	I
<i>Brachiaria deflexa</i>	U	I	D	D	I	U	D	D
<i>Brachiaria leersoides</i>	U	U	D	I	U	U	D	I
<i>Brachiaria ovalis</i>	U	I	D	D	I	U	D	D
<i>Cenchrus ciliaris</i>	U	U	I	D	U	I	I	D
<i>Chloris roxburghiana</i>	U	U	I	U	U	U	D	U
<i>Chloris virgata</i>	U	U	VD	D	I	U	VD	D
<i>Cyperus bulbosus</i>	U	U	D	I	U	U	D	I
<i>Cyperus laevigatus</i>	U	U	D	D	I	D	D	D
<i>Cyperus sp.*</i>	U	U	D	D	I	D	D	D
<i>Digitaria sp.*</i>	U	U	VD	VD	I	I	VD	VD
<i>Digitaria velutera</i>	U	U	VD	VD	I	I	VD	VD
<i>Drake-Brockmania somalensis</i>	U	U	I	I	U	U	I	I
<i>Enneapogon cenchroides</i>	U	I	D	D	I	I	D	D
<i>Enneapogon desvauxii</i>	U	U	D	D	U	U	D	I
<i>Eragrostis cilianensis</i>	U	U	D	D	U	I	D	D
<i>Eragrostis sp.*</i>	U	I	VD	VD	D	D	VD	VD
<i>Heteropogon contortus</i>	U	U	D	D	U	I	D	D
<i>Kyllinga alba</i>	U	U	D	D	D	D	D	D
<i>Leptothrium senegalense</i>	I	D	D	D	I	I	I	I
<i>Lintonia nutans</i>	U	U	D	D	U	U	D	D
<i>Lintonia sp.*</i>	U	U	D	D	U	U	D	D
<i>Microchloa kunthii</i>	U	U	D	D	D	D	D	D
<i>Oropetium minimum</i>	U	U	I	D	U	I	U	D
<i>Pennisetum mezianum</i>	U	U	D	D	U	I	D	D
<i>Setaria pallidifusca</i>	U	U	D	D	U	U	D	D
<i>Setaria plicatilis</i>	U	U	D	D	U	U	I	D
<i>Setaria verticillata</i>	U	U	D	D	U	U	D	I
<i>Sorghum sp. (1)*</i>	U	I	D	D	U	U	D	D
<i>Sorghum sp. (11)*</i>	U	U	D	I	I	U	D	I
<i>Sorghum versicolor</i>	U	I	D	D	U	U	D	D
<i>Sporobolus sp. (1)*</i>	U	U	D	D	D	D	D	D
<i>Sporobolus sp. (11 small)*</i>	U	U	D	D	U	U	D	U
<i>Stipagrostis uniplumis</i>	U	I	I	I	I	I	I	I
<i>Tetrapogon cenchroides</i>	I	U	D	D	I	I	D	D
<i>Tetrapogon spatheceus</i>	U	I	D	D	I	I	D	D
<i>Tragus berteronianus</i>	U	U	D	U	I	U	U	U
Other important species (Creepers, Climbers etc.)								
<i>Cissus rotundifolia</i>	U	U	U	U	U	U	U	U
<i>Euphorbia samburuensis</i>	U	U	U	U	U	U	U	U
<i>Euphorbia tirucalli</i>	U	U	U	U	U	U	U	U
<i>Vigna membranacea</i>	D	D	D	D	D	D	D	E

*Specific name not determined.

The annual plants require special consideration. They contribute to the diets of livestock, especially cattle and sheep, either in their green form in the wet season or in the "standing dead" and litter form in the dry season. Because their presence is unreliable however, they are not normally used for assessing condition. *Blepharis linearifolia* is highly desirable by camels in its dry form, however.

Trees and Shrubs

During wet seasons when a flush of green leaves appears, more than 50% of the trees were found to be utilized by camels and goats (Table 1). There are no records of sheep or cattle consuming trees or large shrubs in the wet season. Since most trees are deciduous, and lose their leaves in the dry season, they are not consumed by livestock. Approximately 50% of the tree species, however, are known to be utilized by camels, 50% by goats, and 16% by sheep, in the dry season. Even cattle have been observed to feed on *Acacia tortilis* flowers, and *Grewia bicolor* and *Boscia angustifolia* which remain green longer than other plant species. Kayongo-Male et al. (1981) recorded *Cadaba* species as constituting 8% of the cattle diets in late October 1981 in the Ngurunit/Lependera area. *Acacia tortilis* pods are known to be eaten by goats and sheep.

Smaller shrubs (about 2 metres high) form an important part of camel and goat diets (Table 1). They are especially browsed in the wet season when about 55% of the total number of shrub species observed are eaten by camels and 62% by goats. Sheep and cattle eat approximately 22% and 6% of this plant category, respectively, in the wet season. (Table 2).

Dwarf shrubs form a major component of the vegetation in the

IPAL study area where they are frequently dominant (Table 1). Dwarf shrubs are important camel and goat browse in all seasons and are also occasionally browsed by cattle and sheep during periods of food scarcity. The most important species are *Acalypha fruticosa*, *Barleria eranthemoides*, *Barleria proxima*, *Indofera spinosa*, *Justicia cearulea*, *Justicia pinguor* and *Plectranthus igniarius*. It is common for species of low palatability in the wet season to become desirable in the dry period as illustrated by *Crotalaria laburnifolia*, and *Satureja abyssinica*. *Duosperma eremophilum*, which is one of the most common dominants of the dwarf shrubs, is only occasionally browsed by camels, goats, and cattle. Other important dwarf shrub species, both in terms of availability and desirability, are *Heliotropium albobispidum* and *Sericocomopsis hildebrandtii*.

Perennial Grasses

Perennial grasses in the IPAL study area are mainly found on the mountains, though they also occur in limited areas of the arid plains. They form the most important plant group for sheep and cattle (Table 1). Certain species have been included in this group because they tend to be either annual or perennial. Lewis (1977) reported similar physiology for *Eragrostis ciliaris*. More than 90% of the observed perennial grasses were desirable to both sheep and cattle in all seasons. The most desirable plants in this group for sheep and cattle was *Dichanthium insculptum* (Table 1). In the case of goats, as much as 60% of the perennial grasses present were found to be desirable (Table 2). Even for camels, which are generally considered to be nongrazers, our observations indicated that about 14% and 19% of the total number of perennial grasses were

Table 2. Desirability rating of the various plant species as percentage (%) of the total species in each class for different livestock species.

	Wet Season				Dry Season			
	VD	D	I	U	VD	D	I	U
Camels								
Tree and large shrubs	2	26	29	43	2	24	14	60
Shrubs	6	33	17	44	—	17	22	61
Dwarf Shrubs	6	41	15	38	3	41	29	27
Perennial grasses	—	—	14	86	—	—	18	82
Herbs	3	16	10	71	2	4	9	85
Annual grasses	—	—	5	95	5	—	24	71
Others	7	43	29	21	14	—	—	86
Sheep								
Trees and large shrubs	—	—	—	100	—	5	11	84
Shrubs	—	5	17	78	—	—	11	89
Dwarf shrubs	—	23	15	62	—	12	35	53
Perennial grasses	5	86	5	5—	82	9	9	—
Herbs	3	12	20	63	3	2	10	85
Annual grasses	10	74	16	—	8	74	13	5
Others	21	29	14	36	—	14	—	86
Goats								
Trees and large shrubs	5	34	13	48	2	21	27	50
Shrubs	6	22	33	39	—	11	33	56
Dwarf shrubs	7	33	18	42	1	28	42	29
Perennial grasses	—	36	23	41	—	23	36	41
Herbs	4	24	32	40	2	4	16	78
Annual grasses	—	11	42	47	—	21	32	47
Others	14	50	14	22	15	22	—	63
Cattle								
Trees and large shrubs	—	—	—	100	—	—	3	97
Shrubs	—	—	6	94	—	5	12	83
Dwarf shrubs	—	3	9	75	—	12	29	59
Perennial grasses	4	86	5	5	—	86	5	9
Herbs	3	5	13	79	3	2	10	85
Annual grasses	10	75	13	2	9	61	24	6
Others	—	36	—	64	—	7	14	79

VD = Very desirable, D = Desirable, I = Intermediate, U = Undesirable.

eaten by camels in the wet and dry seasons respectively.

Broadleaf Herbaceous Plants

The greatest proportion of the 68 broadleaf herbaceous plants encountered in our studies are annuals. Thus when they are eaten in the dry seasons, they are usually dried. The species most preferred are *Cammelina africana* and *Cameliana benghalensis*, which are preferred by cattle, sheep, camels, and goats in all seasons (Table 1). *Indigofera caerulea* on the other hand, was found to be very desirable for camels and goats and desirable for sheep in all seasons, although it was intermediate for cattle in the dry season and undesirable for cattle in the wet season. Despite its spines, *Blepharis linarifolia* is eaten by camels in the wet and dry seasons, as well as cattle, sheep, and goats in the wet season. Because many of the species are desirable only in the wet season, they are not available in the dry periods (Table 1).

Annual Grasses and Sedges

The ground layer of the IPAL study area is dominated by annual grasses, notably *Aristida* spp. Annual grasses compose the bulk of cattle and sheep diets, a substantial proportion of the diet of goats, and a small but significant contribution to the diet of camels (Table 1). *Digitaria* sp., *D. velutina*, and *Eragrostis* sp. are very desirable for cattle and sheep in all seasons. Another highly preferred plant is *Chloris virgata*. In fact, only a minor percentage of the plants in this category was recorded as undesirable for cattle and sheep, mainly in the dry season. Undesirables include *Oropetium minimum* and *Tragus berteronianus*, which are both very small plants that are not readily available or have sharp, prickly seeds. In the dry season, annual grasses and sedges are eaten standing dead or as litter by livestock. In certain arid conditions such as are commonly found in the IPAL study area, this may be the only food available to the animals. All the sedges encountered, *Cyperus laevigatus*, *C. bulbosus*, *C. sp.*, *Kyllinga alba*, were desirable for cattle, sheep, and goats, but not for camels.

Other Important Species

The last category to be considered includes creeping and climbing plants. Since the majority of these plants are drought-deciduous, their use by livestock is largely confirmed to the wet seasons (Table 1). However, a few of them are utilized by livestock in the dry season since their stems remain fleshy. The most preferred species in this group is *Kandrostis gijef* which is highly desirable for camels, sheep, goats, and cattle even in its leafless form. Other preferred species are *Rhynchosia minima*, *Rhynchosia sp.*, *Rhynchosia sublobata*, *Mormodica sessifolia*, and *Vigna membranacea*. The majority of the plants in this category are desirable in the wet season, especially for camels, sheep, and goats.

Summary

A look at the classification indicates that most of the plants in the study area are used by livestock at different times of the year. There is a clear overlap in the diets of camels and goats and also cattle and sheep. Since this area is used traditionally by all these kinds of livestock, diet overlap should be considered while recommending stocking rates. Manipulation of the range for better primary production should also take into account the needs of the different livestock species on a common use range.

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