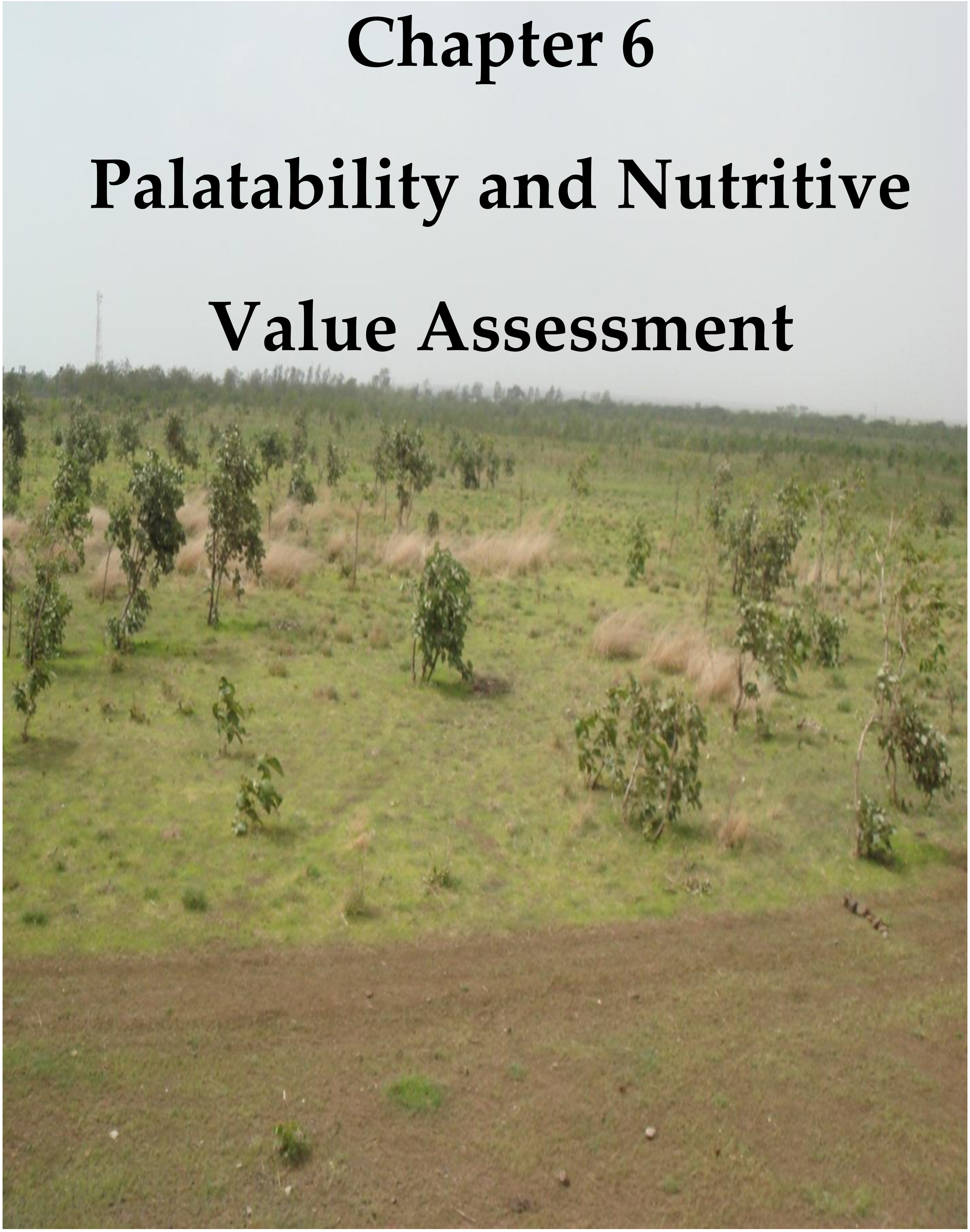
Chapter 6

Palatability and Nutritive Value Assessment



Chapter 6

Palatability and Nutritive Value Assessment

The term 'palatability' cannot be defined exactly since it is a concept rather than an exact scientific term (Marten, 1969). The palatability of a food is considered to reflect those of its characteristics which invoke a sensory response in the animal. In nutritional science a food is often said to be palatable if it is selected in preference to other foods offered simultaneously. Palatability or high acceptance of forage by an animal may be affected by texture, aroma, succulence, hairiness, leaf %, fertilization, sugar content, tannins, and alkaloids. High palatability may improve intake by the animal. The faster the growth rate of the pasture, the higher will be the quality and palatability (and thus intake) of the herbage on offer to the animals. The palatability of a forage is affected by its taste (sweet, salty, bitter, acidic), olfactory and textural characteristics. Taste is normally the major factor affecting palatability. The preference of a grass species as fodder depends upon its palatability.

Forage palatability is based on a combination of many things such as plant species, nitrogen fertilization, and maturity. Other aspects of palatability are a result of acquired preferences or aversion (based on satisfaction or discomfort), learning experiences in early life with the mother, and desire for variety in the diet. Grazing management or mismanagement can affect palatability of forage available in a pasture. Careful observation of livestock during grazing can assist in getting better utilization of the forage (Carl S. Hovelqn C. S. 1996).

Grasses and legumes are the two most important plant families worldwide in providing food for both humans and animals. Incorporation of legume plant herbage, contributes to the high protein concentration, palatability, and nutritive value of forage used for livestock. Several species of biennial and perennial legumes have been utilized for pasture, harvested forage, and soil improvement and stabilization. Being a natural nitrogen fixer, legumes associated with the forage grasses surely increase the vegetative growth of pasture.

The general assumption says that as the fiber content increases the toughness also increases and taste decreases. Evidence suggests that leaves become more palatable as nitrogen contentand specific leaf area increase and fiber content and tensile strength decrease (Coley et al. 1985; Wright and Illius 1995). Therefore the leafy grass species are more preferable for cattle. But the fiber content of leaf only does not satisfy the need of cattle, alongwith it the protein and carbohydrate content, lignin content, cellulose content, etc. are also considered as an important aspect of palatability.

Preference of a grass species as fodder depends upon its palatability. Grass like all green plant capture energy from the sun and convert the energy into sugars and carbohydrates which is eventually used, along with plant nutrients and minerals for growth, development and reproduction. Warm season grasses produced more leaves than stems in their immature stage early in their life cycle. Immature leaf tissue is low in fiber and contains high leaves of soluble proteins, fats, carbohydrates and oils which meet or exceed the nutrient demands of most grazing animals while stems are high in digestible nutrients. Grasses can be harvested heavily during the leaf stage.

Palatability is consumption of plant or plant parts with relish by grazing animal (Husain and Durrani, 2009). Generally palatability and preference are used as synonymous, though preference is essentially behavioral, which is totally depending on the choice of the grazing animals (Ivins, 1952). The palatability of the grass is dependent on the chemical constituents and nutritional content such as carbohydrates, proteins, fiber etc. and their proportions, which are regulated by environmental factors like topography, climate etc. (Jawed et al., 2008). At the maturity of the grass, protein content decreases, while fiber, lignin, cellulose etc. increases, hence grasses are more acceptable when they are young (Heady, 1964; Mirza et al., 2002).

The studied grasslands are exposed to anthropocentric activities like burning and grazing and are facing several changes like replacement of palatable species by unpalatable ones. Grasslands in this region are either exposed to cattle grazing or the grass is being harvested and fed to cattle. Burning is another activity that is often practiced in the study area. This is done by local people as well as forest staff with a point of view that after burning the grassland would facilitate growth of new grasses through seed germination in the next season. But these activities have resulted in palatable grasses being slowly replaced by unpalatable grasses. To augment palatable species in grasslands is the biggest challenge in front of grassland managers of this region. Thus, the study for assessing selected grass species for better development of such more palatable species was undertaken.

Materials and Method

In the present study, the attention was made to evaluate the effect of the different maturity stages and storage period on the palatability of the hay. For this study we estimated the nutritional values (carbohydrate and protein content) and palatability values (Cellulose, Hemicellulose, ADF, NDF, crude fiber content).
The values for nutrition and palatability were assessed for fresh as well as mature (before seed setting) stored plant material

- Nutritive values were assessed by estimating total soluble sugars and the protein contents.
- Palatability for the selected grasses was assessed by estimating their ADF, NDF values, ADL, Lignin, Cellulose, Hemicellulose and Crude fiber contents.

Estimation of total soluble sugars (Yemn and Willis, 1954)

Method

- 100mg of the sample was taken into a tube.
- It was hydrolyzed by keeping it in a boiling water bath for 3h with 5ml of 2.5N HCl and then cooled to room temperature.
- It was neutralized with solid sodium carbonate until the effervescens ceased.
- The volume was made up to 100ml and centrifuged.
- The supernatant was collected and 0.5 and 1ml of aliquots were taken for analysis.
- The volume was made up to 1ml by adding distilled water.
- 4ml of Anthrone reagent was added.
- Each test-tube was heated for 8 min in a boiling water bath.
- After rapid cooling, the green to dark green color was read at 630 nm.
- Standard graph was prepared with standard glucose.

Calculation

Amount of carbohydrate present in sample (% mg) =

$$\frac{\text{Sugar value from graph (mg)}}{\text{Aliquote sample used (0.5 / 1ml)}} \times \frac{\text{Total volume of extract (ml)}}{\text{Wt. of sample (mg)}} \times 100$$

Estimation of protein (Lowry et al. 1951)

Extraction of protein from sample

0.5g of the sample was ground with a suitable solvent system (water or buffer) in a pestle and mortar. Then it was centrifuged and the supernatant was used for protein estimation.

Estimation of protein

- 0.1ml and 0.2ml of the sample extract was taken.
- The volume was made up to 1ml with water in all the tubes. A tube with 1ml of water serves as the blank.
- 5ml of solution C was added, mixed well and incubated at room temperature for 10 min.
- 0.5ml of FCR was added, mixed well immediately and incubated at room temperature in dark for 30 min.
- The absorbance was read at 660nm against blank.
- Standard graph was drawn, the amount of protein in the sample was calculated and expressed the results as mg/100g sample or percentage.

Estimation of lignins (Goering and VanSoest, 1970)

Method

A. Acid detergent fibre (ADF)

- 1g of powdered sample was placed in a round bottom flask and 100ml of acid detergent solution was added, boiled for 5 to 10 min.
- Container was removed, swirled and filtered the contents through a pre-weighed sintered glass crucible (G-2) by suction and washed with hot water twice.

- Then again washed with acetone and broken up the lumps. Acetone washing was repeated until the filtrate became colorless.
- Dried it at $100^{0}C$ for overnight.
- After cooling in desiccator, it was weighed.

Calculation for ADF (%) = W/S x 100.

Where 'W' is the weight of the fibre and 'S' is the weight of the sample.

B. Acid detergent lignin (ADL)

- ADF was transferred to 100ml beaker with 25-50ml of 72% sulphuric acid. 1g asbestos was added. Allowed to stand for 3h with intermittent stirring with a glass rod.
- Acid was diluted with distilled water and filtered with pre-weighed Whatman No.1 filter paper. Glass rod and the residue were washed several times to get rid of the acid.
- Filter paper was dried at $100^{0}C$ and weighed after cooling in desiccators.
- Filter paper was transferred to pre-weighed silica crucible and filter paper was ashed with the content in a muffle furnace at $550^{0}C$ for about 3h.
- Crucible was cooled in desiccators and weighed, ash content was calculated.
- Blank used was 1 g of asbestos, which was subjected to same procedure.

Calculation

$$\text{Weight of 72\% } H_2SO_4 \text{ (\% ADL)} = \frac{\underset{\text{Washed fibre}}{\text{(Test-asbestos blank)}} - \underset{\text{Ash}}{\text{(Test-asbestos blank)}}}{\text{Weight of sample}} \times 100$$

Cellulose = ADF – Residue after extraction with 72% H_2SO_4

Lignin = Residue after extraction with 72% H_2SO_4 – Ash

ADF = Cellulose + Lignin + Minerals

NDF = Hemicellulose + Cellulose + Lignin + Minerals

<u>Estimation of Crude fibers (AOAC, 2005)</u>

Method

- 2g of ground sample was extracted with ether or petroleum ether to remove fat (initial boiling temperature was 35-38^{0}C and final temperature, 52^{0}C. If fat content is less than 1% extraction may be omitted).
- 2g of dried sample was boiled with 200ml of H_2SO_4 for 30 min with bumping chips.
- Filtered through muslin cloth and washed with boiling water until washings were free of acid.
- Residue was boiled with 200ml of NaOH for 30 min.
- Filtered again through muslin cloth and washed with 25 ml of boiling H_2SO_4, three 50ml portions of water and 25ml of alcohol.
- Residue was removed and transferred to pre-weighed ashing dish (W_1, g).
- Residue was dried for 2h at 130$\pm$2^{0}C, cooled in a desiccators and weighed (W_2, g).
- Ignite for 30 min at 600$\pm$15^{0}C.
- Cooled in a desiccators and reweighed (W_3, g).

Calculation

$$\% \text{ Crude fiber content} = \frac{\text{Loss in weight on ignition } \times (W_2 - W_1) - (W_3 - W_1)}{\text{Weight of Sample (g)}} \times 100$$

Results and Discussion

Common and most palatable grasses in the study area include *Apluda mutica* (Karedi), *Bothriochloa pertusa* (Zinzavi), *Cenchrus ciliaris* (Anjan), *Chrysopogon fulvus* (Khad), *Coix lachryma-jobi* (Kaha), *Dichanthium annulatum* (Zinzavo), *Echinochloa crusgalli* (Samo), *Eragrostis tenella* (Bhumsi), *Heteropogon contortus* (Sukli), *Sehima nervosum* (Shaniyar), *Sehima sulcatum* (Seran), *Themeda triandra* (Bhathedu), etc. While common legume species include mainly weed forms i.e. *Alysicarpus monilifer* (Lipodi), *Alysicarpus vaginalis* (Lipodi), *Atylosia scarabaeoides* (Ajimo), *Cassia tora* (Puvad), *Indigofera cordifolia* (Gobaru), *Indigofera echinata* (Gobaru), etc.

A checklist of palatable grass species from both the studied grasslands was compiled to understand the status of fodder potential of grasslands. The grasslands are dominated by un-palatable species as these species are slowly replacing palatable species. All palatable grass species show a different palatability grade which can be assessed based on their consumption and animal preference to eat them. From this checklist (Table 6.1) it can be seen that some species were rare but still can be consumed by cattle and species like *Iseilema laxum,* an excellent fodder grass can be established as pure patches in the grassland. Other rare species like *Eragrostis japonica, Eragrostis nutans, Eragrostis tremula, Eragrostis unioloides, Isachne globosa, Ischaemum indicum, Oplismenus burmannii, Sporobolus halvolus,* etc. are good fodder grasses; which can also be established in pure patches in the grassland. As a result of this cultivation the forest department as well as local tribals can overcome the problem of fodder for the cattle and that is specially in scarcity period when availability of forages is about to zero or very less.

Table 6.1 Checklist of palatable grasses

Sr. No.	Name of grasses	Awns	Habitats	Status of Occurrence	Palatability Grade
1	*Alloteropsis cimicina* (L.) Stapf	P-r	3	O	B
2	*Andropogon pumilus* Roxb.	P-l	3	O	A
3	*Apluda mutica* L.	P-l	1,3	C	B
4	*Aristida adscensionis* L.	P-l	1	C	C
5	*Aristida funiculata* Trin. and Rupr.	P-l	2	C	C
6	*Arthraxon lanceolatus* (Roxb.) Hochst.	P-l	3	O	B
7	*Bothriochloa pertusa* (L.) A. Camus	P-l	3	C	B
8	*Brachiaria eruciformis* (J. E. Sm.) Griseb.	Ab	3	O	C
9	*Brachiaria reptans* (L.) Gard. and Hubb.	Ab	3	O	C
10	*Capillipedium huegelii* (Hack.) Stapf	P-l	1	O	C
11	*Cenchrus biflorus* Roxb.	P-r	3	R	C
12	*Cenchrus ciliaris* L.	P-r	2	C	A
13	*Cenchrus setigerus* Vahl	P-r	1	O	C
14	*Chionachne koenigii* (Spr.) Thw.	Ab	4	O	C
15	*Chloris barbata* Sw.	P-r	1,3	O	C
16	*Chloris virgata* Sw.	P-r	1,3	C	B
17	*Chrysopogon fulvus* (Spr.) Chiov.	P-l	1	VC	B
18	*Coix lachryma-jobi* L.	Ab	4	O	C
19	*Cymbopogon martinii* (Roxb.) Wats.	P-l	1	VC	UP
20	*Cynodon dactylon* (L.) Pers.	Ab	1,3	VC	B
21	*Dactyloctenium aegyptium* (L.) P. Beauv.	Ab	1	C	C
22	*Desmostachya bipinnata* (L.) Stapf	Ab	1	C	UP
23	*Dichanthium annulatum* (Forssk.) Stapf	P-l	1,3	C	A
24	*Dichanthium caricosum* (L.) A. Camus	P-l	1	O	A
25	*Digitaria adscendens* (H. B. and K.) Henr.	Ab	1,3	VC	B
26	*Digitaria granularis* (Trin. ex Spr.) Henr.	Ab	2	O	C
27	*Dinebra retroflexa* (Vahl) Panz.	Ab	3	O	B
28	*Echinochloa colonum* (L.) Link	Ab	1,3	C	B

Sr. No.	Name of grasses	Awns	Habitats	Status of Occurrence	Palatability Grade
29	*Echinochloa crusgalli* (L.) P. Beauv.	Ab	1,3	C	B
30	*Echinochloa stagnina* (Retz.) P. Beauv.	Ab	4	R	A
31	*Eleusine indica* (L.) Gaertn.	Ab	1	O	B
33	*Eragrostiella bifaria* (Vahl) Bor	Ab	2	O	B
34	*Eragrostis cilianensis* (All.) Link	Ab	Disturbed areas	R	C
35	*Eragrostis ciliaris* (L.) R. Br.	Ab	1	O	B
36	*Eragrostis japonica* (Thunb.) Trin.	Ab	4	R	B
37	*Eragrostis nutans* (Retz.) Nees and Steud.	Ab	4	R	B
38	*Eragrostis tenella* (L.) P. Beauv.	Ab	1	C	B
39	*Eragrostis tremula* Hochst.	Ab	3	R	B
40	*Eragrostis unioloides* (Retz.) Nees	Ab	1	R	B
41	*Eragrostis viscosa* (Retz.) Trin.	Ab	4	R	C
42	*Hackelochloa granularis* (L.) O. Ktze.	Ab	1,3	C	B
43	*Heteropogon contortus* Blatter and McCann	P-l	1,2,3	VC	B
44	*Imperata cylindrica* (L.) P. Beauv.	Ab	4	C	UP
45	*Isachne globosa* (Thumb.) O. Ktze.	Ab	4	R	B
46	*Ischaemum indicum* (Houtt.) Merr.	P-l	3	R	B
47	*Ischaemum molle* Hk. f.	P-l	3	O	B
48	*Ischaemum pilosum* (Klein ex Willd.) Wt.	P-l	3	C	B
49	*Ischaemum rugosum* Salisb.	P-l	3	O	B
50	*Iseilema laxum* Hack.	P-l	3	R	A
51	*Melanocenchris jacquemontii* J. and S.	P-r	2	C	C
52	*Ophiorus exaltatus* (L.) O. Ktze.	Ab	1	C	B
53	*Oplismenus burmannii* (Retz.) P. Beauv.	Ab	3	R	B
54	*Oropetium thomaeum* (L. f.) Trin.	Ab	2	O	
55	*Panicum antidotale* Retz.	Ab	3	O	A
56	*Panicum trypheron* Schult.	Ab	1,3	O	A
57	*Pennisetum setosum* (Sw.) L. C. Rich.	P-l	1	R	B
58	*Paspalidium flavidum* (Retz.) A. Camus	Ab	1,3	C	B

Sr. No.	Name of grasses	Awns	Habitats	Status of Occurrence	Palatability Grade
59	*Perotis indica* (L.) O. Ktze.	P-r	3	O	B
60	*Rottboellia exaltata* L. f.	Ab	3	R	B
61	*Schoenefeldia gracilis* Kunth	P-r	1	C	C
62	*Sehima ischaemoides* Forssk.	P-l	1	C	B
63	*Sehima nervosum* (Rottl.) Stapf	P-l	1	C	A
64	*Sehima sulcatum* (Hack.) A Camus	P-l	1	C	A
65	*Setaria glauca* (L.) P. Beauv.	Ab	1	C	C
66	*Setaria tomentosa* (Roxb.) Kunth	Ab	1	O	C
67	*Setaria verticillata* (L.) P. Beauv.	Ab	1	O	C
68	*Sorghum halepense* (L.) Pers.	P-l	1	C	UP
69	*Sporobolus diander* (Retz.) P. Beauv.	Ab	1	C	C
70	*Sporobolus fertilis* (Steaud.) Clayton	Ab	1	R	C
71	*Sporobolus halvolus* (Trin.) Thw.	Ab	1	R	B
72	*Sporobolus marginatus* Hochst. ex A. Rich.	Ab	1	R	C
73	*Thelepogon elegans* Roth ex R. and S.	P-l	1	O	C
74	*Themeda cymbarica* (Roxb.) Hack.	P-l	1	O	C
75	*Themeda laxa* (Anderss.) A. Camus	P-l	1	R	
76	*Themeda triandra* Forsk.	P-l	1	C	C

Abbreviations: Awns: P- present; -l – lax awn; -r – rigid awn; Ab- absent. Habitats: 1- grassland grass; 2- stony area; 3- moist area; 4- water logged area or shores of pond or lake. Status: Occurrence of the species- C-common; O-occasional; R-rare. Palatability Grade: A - Very good or excellent fodder; B - Good fodder grass; C - Grasses consumed when young or consumed when good palatable fodder species are not available; Up - Unpalatable.

Generally, legumes have higher protein content than grasses. This protein content of plant is affected by stage of maturity and mainly decreases as the plant matures. As forage plant mature, the nutritional value also changes, e.g. plants have more fiber and less protein as they mature. That's why we incorporate the suggested values for fresh as well as mature (before seed setting) stored plant material (Table 6.2). The main indicators of maturity are flowers for legumes and seed heads for grasses. Thick stem in both cases also indicates the maturity of plants.

This is often difficult or impossible to achieve, since selection of forage material is based on what is available rather than what may be desirable. As the study area was unexploited and there is demand of healthy forage for the livestock, in present study we tried to understand about the palatability potentials present in some dominant and few rare grass species at two different stages. The rare species were selected because if they exhibit good quality of forage then those species can be cultivated in pure patches.

Table 6.2 Nutritive and palatability values

Sr. No.	Species	Stage of Maturity	Moisture content	CP%	TSS%	ADF%	NDF%	Lig%	HCe%	CF%	Ash%
1	*Apluda mutica*	Fresh	17	4.2±0.22	3.8±0.11	10.3±0.58	41.1±0.31	3.1±0.08	24.0±0.16	31.3±0.15	5.3±0.11
		Stored	9	2.4±0.22	3.1±0.13	13.9±0.28	49.0±0.21	4.2±0.10	28.9±0.15	27.4±0.19	6.8±0.19
2	*Bothriochloa pertusa*	Fresh	12	8.6±0.32	8.1±0.11	32.9±0.16	58.9±0.41	4.1±0.11	33.9±0.13	34.1±0.13	8.8±0.11
		Stored	7	6.0±0.10	6.8±0.11	36.9±0.26	65.0±0.30	5.9±0.11	38.0±0.16	31.3±0.15	9.3±0.15
3	*Cappilipadium hugelli*	Fresh	12	7.8±0.42	3.3±0.15	21.9±0.27	46.0±0.45	3.2±0.11	23.0±0.16	36.8±0.17	8.4±0.19
		Stored	7.5	5.5±0.17	2.3±0.15	30.0±0.31	52.9±0.24	4.2±0.11	27.0±0.21	32.2±0.16	9.3±0.16
4	*Cenchrus ciliaris*	Fresh	14	9.7±0.15	7.6±0.19	31.0±0.25	63.4±0.87	3.8±0.17	32.9±0.27	38.3±0.18	9.7±0.15
		Stored	8	7.4±0.18	6.7±0.22	32.8±0.19	68.9±034	5.4±0.11	36.0±0.16	35.2±0.15	11.5±0.23
5	*Coix lachryma-jobi*	Fresh	20	9.7±0.25	8.2±0.19	28.9±0.31	65.0±0.19	4.1±0.11	34.0±0.19	35.1±0.18	8.7±0.15
		Stored	12	6.4±0.11	6.4±0.11	32.0±0.27	69.0±0.31	5.2±0.11	38.0±0.11	31.8±0.17	10.2±0.17
6	*Dichanthium annulatum*	Fresh	19	5.8±0.22	3.8±0.11	30.8±0.24	56.8±0.31	4.3±0.11	26.0±0.23	41.3±0.13	9.8±0.17
		Stored	9	2.7±0.21	2.7±0.15	34.0±0.13	65.8±0.31	5.3±0.08	32.1±0.23	39.2±0.11	11.5±0.19
7	*Echinochloa colonum*	Fresh	19	6.1±0.11	3.7±0.11	11.0±0.21	33.1±0.27	2.9±0.11	22.0±0.17	28.5±0.11	6.3±0.21
		Stored	10	5.4±0.15	3.3±0.16	14.9±0.32	36.0±0.27	3.8±0.11	26.9±0.23	25.5±0.21	7.1±0.11
8	*Ischaemum rugosum*	Fresh	15	6.7±0.15	3.3±0.17	18.1±0.42	42.0±0.21	3.8±0.23	21.1±0.16	31.3±0.18	7.8±0.13
		Stored	10	3.4±0.15	2.1±0.11	20.9±0.30	49.0±0.27	5.1±0.13	27.8±0.11	28.1±0.11	10.5±0.21
9	*Schoenefeldia gracilis*	Fresh	14	3.5±0.11	4.4±0.22	11.9±0.24	39.0±0.16	3.6±0.11	28.9±0.21	33.5±0.22	6.6±0.23
		Stored	7	1.7±0.21	2.3±0.11	18.9±0.30	42.0±0.27	4.8±0.08	34.9±0.16	29.4±0.11	10.3±0.15
10	*Sehima nervosum*	Fresh	16	8.8±0.17	6.7±0.16	28.9±0.29	58.9±0.15	4.3±0.08	31.0±0.13	33.0±0.19	10.3±0.22
		Stored	8.5	6.3±0.12	3.4±0.11	30.0±0.32	62.0±0.31	5.5±0.08	33.9±0.21	30.1±0.15	14.2±0.21

Abbreviations: CP – Crude protein, TSS – Total soluble sugars, ADF – Acid detergent fibres, NDF – Neutral detergent fibres, Lig – Lignin, HCe – Hemicellulose, CF – Crude fibres

Among the selected grasses, *Coix lachryma-jobi* showed maximum amount of nutritive values for freshly collected plant material, while *Cenchrus ciliaris* showed maximum amount of nutritive values for stored material. The results of palatability assessment showed that among structural components maximum amount of ADF was present in *Bothriochloa pertusa* in fresh as well as stored material. While NDF amount was maximum for *Coix lachryma-jobi* for fresh material and for stored material the maximum amount of NDF was present in *Cenchrus ciliaris* and *Coix lachryma-jobi.* Likewise, amount of lignin was maximum in *Dichanthium annulatum* and *Sehima nervosum* for fresh material while for stored material it was maximum in *Bothriochloa pertusa*. The amount of hemicellulose was maximum for fresh as well as stored material in *Bothriochloa pertusa* and *Coix lachryma-jobi.* The maximum amount of crude fibers was present in *Dichanthium annulatum* in fresh as well as stored material. Ash content was maximum in fresh material of *Cenchrus ciliaris* and *Dichanthium annulatum* while in stored material it was maximum in *Sehima nervosum.*

Moisture content is one of the most important factors affecting the harvest, trading, storing, and handling of hay and forages. The moisture or water content of the feed is a key component that is often neglected but is frequently limiting particularly in tropical situations and especially in lactating animals. Much of the animal’s water is likely to come from the feed, particularly when the animal is grazing or browsing lush vegetation. Once harvested, feeds with high moisture content are liable to spoil quickly, mostly from fungal contamination. The moulds and more particularly the toxins that are produced by many moulds make the feed unpalatable and can cause illness or even death to both the animals and people handling the feed. On the other hand, very dry feeds, while being stable during storage, are less palatable for the animal and also increase the animal's requirement for water. Moisture content for both stages was calculated before going for further analysis. In the present study, all species show decrease in moisture content by 5 to 10 percent from fresh to stored material.

Energy in feedstuffs is carried primarily in the carbohydrate and fat fractions. Proteins also supply energy when fed in excess of protein needs. As with energy, the animal needs a certain amount of protein just to maintain itself. Animals are not able to store protein, and so continually need to be supplied with protein because animals are constantly breaking down their body's proteins and then building them back up again. As this process is never completely efficient, there is always some protein that is being excreted (as ammonia in the urine or as uric acid – non protein nitrogens), and this must be replaced if the animal is not to lose weight.

Along with protein, carbohydrates are also important to maintain energy level in the body which makes up 65 to 75 percent of the dry weight of forages. They include sugars, starch, cellulose, hemicellulose and lignin. Forages contain moderate amount of sugars, and the sugar content can be greatly affected by forage variety (Humphreys 1989; Berthiaume et al. 2010). The sugar content of forage is also affected by maceration and harvest time (a.m. or p.m.). Plants accumulate sugars during the daytime by photosynthesis, and consume sugars by respiration during the night-time. Thus, forages harvested in late afternoon are expected to have greater sugar content compared with those harvested in the morning (Oba M. 2010).

Crude Fiber is an estimate of the indigestible or only slowly digestible fraction of the feed. As crude fiber increases, digestible energy usually decreases. For most forages, as plant maturity increases the amount of fiber (cell wall constituents) increases. The fiber component of feed is the lignin, cellulose and hemicellulose in the plant. It includes three parameters ADF (Acid Detergent Fiber), NDF (Neutral Detergent Fiber) and lignin. ADF indicates the amount of cellulose and lignin in the feed while NDF represents all of the fiber in the plant including hemicellulose, cellulose and lignin. The higher level of ADF in feed is being put in the rumen and can not be used. Likewise, higher level of NDF in feed will discourage feed intake and again result in deficiency of protein and energy.

Cellulose, the most abundant of fiber constituents in feeds, provide tensile strength to plants. It is a polymer of glucose and is the most abundant organic material in nature. It is however, resistant to decomposition.

Hemicelluloses in the plants, present are generally the second most abundant class of fiber components. They are polymers of simple sugars such as pentoses, hexoses and uronic acid.

Lignin is the third most abundant constituent of plants. The degradation of lignin is very slow and the rate of decomposition depends on the presence of other compounds such as cellulose and hemicelluloses. In fact, the rate of decomposition of plant material is determined to a great extent by the amount of lignin it contains. An increasing amount of lignin in plant materials leads to a decreased rate of decomposition. Lignin is highly resistant to microbial degradation however; certain fungi are known to degrade.

Results of the study suggest that species like, *Dichanthium annulatum*, *Bothriochloa pertusa*, etc. in their bloom stage are preferable as they possess more amount of crude fibers. The species which show higher amount of crude fiber, lignin, cellulose, hemicellulose should readily given in their vegetative or early bloom stage and if possible fresh. This will increase digestibility and also fulfills the energy requirements of cattle.

The ash content of the feed contains all the minerals, but can also contain some soil contaminants associated. The ash content of a feed says nothing about the quality of the feed's mineral content and other.

Forage quality can be defined simply as the ability of fed to digest and utilize the nutrient components provided by the forage source. The higher the content and digestibility of nutrients, higher the quality of the forages. As the forage matures, its digestibility, rate of digestion and CP content decline, lowering the quality.

The nutritive values i.e. crude protein and total sugars and structural constituents of grasses (palatability values) at early vegetative and hay are presented in Table 6.2. The results supported findings of Distel et al., (2005) who reported that CP contents in different grass species declined with time. The structural constituents (NDF, ADF and lignin) increased in grasses from early bloom to maturity stage. According to Cherney et al., (1993), the tropical grasses generally show an increase in structural constituents with increasing maturity. The findings of this study were in same line. Brown et al., (1984) reported that the soil fertility could also influence grass lignin concentration.

Palatability is an important factor for selection of grass as fodder. ADF and NDF values are key chemical analysis used by nutritionists to evaluate fibrousity and energy value of forage. NDF is made up of the main components like cellulose and lignin as lignin level increase, digestibility of forage decreases. NDF digestibility of forage is done for several reasons the most important one is its relation to location (Robinson, 1999). Crude protein and NDF content were analyzed to record ecotypic variations in few grass populations. Negative correlation has been observed by Sultan et al., (2008) between in vitro digestible matter and NDF, ADF and Lignin values.

Gabrielsen et al., (1990) and Van Soest (1965) reported that NDF, ADF and lignin concentration increased with maturity while IVDMD (*In vitro* dry matter digestibility) and CP declined. Revell et al., (1994) reported a positive correlation between CP and digestibility, whereas, Cherney et al., (1990) observed negative correlation of IVDMD with NDF, ADF and lignin. It had been reported that cell wall component, NDF, ADF and lignin were negatively correlated with IVDMD in tree leaves (Perveen, 1998).

In the present study, obtained results suggests that the promotion of highly palatable species like *Bothriochloa pertusa, Cenchrus ciliaris, Coix lachryma-jobi, Dichanthium annulatum, Sehima nervosum, etc.* must be enhanced. While spread of unpalatable or less palatable species like *Cymbopogon martinii, Sorghum halepanse,* etc. should be controlled. Other less palatable species can be used during drought periods.

In the present study area, during monsoon period, the growth of natural grasses was appreciable and plenty of grasses are available. Species like *Bothriochloa pertusa, Chrysopogon fulvus Dichanthium annulatum, Heteropogon contortus, Sehima nervosum* and *Sehima sulcatum* were highly palatable grasses and are used abundantly. According to local tribals of the study area, *Cymbopogon martinii* is palatable but only in the vegetative and bud condition. *Sorghum halepanse* is not a palatable grass. Cattle never prefer this grass as food, especially when it is in vegetative and flowering stage. It is considered to be toxic during this period. But after seed dispersal and drying this grass is eaten by cattle especially in a scarcity period. *Ophiorus exaltatus* is not palatable as well as not useable grass. It has an allelopathic effect; other grasses do not grow where this species is growing. This species occurs especially where soil is black and sticky.

A feed provides a range of different nutrients, and possible toxic or anti-nutritive factors as well. It may be palatable and readily eaten by livestock, or unpalatable and avoided by livestock. It may be suitable for some classes of livestock but not others. It may be ideal as a supplement to an otherwise marginally deficient diet, or a good basis to the diet provided other key nutrients are provided by other supplements.

All these factors contribute to the overall value of the feed, and this ultimately requires the feed to be fed to an animal to determine what its effect on the animal is. This is the basis to farmer's assessment of a feed, and any information on farmers' perceived value of a feed and its ranking compared with others is extremely important. However, gathering such information has rarely been done systematically and so there are relatively few reports that provide information on the farmers' assessment of different feeds. An important first step, therefore, is to find out what experience farmers have of a particular feed. Some work that has been done on collating farmer's assessments of forages can be found in the publication by Komowihangilo et al., (1995).

Lignin digestibility of plants is quite unpredictable and variable by ruminants. It was observed in present study that non or less palatable species grow vigorously with better distribution and plant cover. The percentage availability of palatable species declined after October - November due to cold dormant season and this is the part of the year where livestock suffer the most. At this stage animal are compelled to utilize even non-palatable forage. Further study is needed to evaluate the nutritional and mineral status of some of the important plants. The rangeland has the potential for improvement, provided proper ecological management practices and local participation of the community is involved.

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