ECOLOGICAL EVALUATION OF PLANT RESOURCES AND VEGETATION STRUCTURE OF DISTRICT TANK, PAKISTAN

BY

LAL BADSHAH

DEPARTMENT OF BOTANY
UNIVERSITY OF PESHAWAR
PESHAWAR
2011

DEDICATION

Sincerely dedicated to
my parents and teachers

University of Peshawar

Peshawar

ECOLOGICAL EVALUATION OF PLANT RESOURCES AND VEGETATION STRUCTURE OF DISTRICT TANK, PAKISTAN

A dissertation submitted in partial satisfaction

of the requirement for the degree of

Doctor of Philosophy

in

Botany

By

Lal Badshah

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ABSTRACT

ECOLOGICAL EVALUATION OF PLANT RESOURCES AND VEGETATION STRUCTURE OF DISTRICT TANK, PAKISTAN

By

LAL BADSHAH

This study was conducted to assess the ecological resources of District Tank during 2007- 2010 in different seasons. The floristic diversity consisted of 205 species within 56 families. Based on number of species, Poaceae (34 Spp), Papilionaceae (19 Spp), Asteraceae (14 Spp), Chenopodiaceae (10 Spp) and Brassicaceae (9 Spp), Euphorbiaceae (8 Spp), Boraginaceae, and Polygonaceae, (each with 7 species) were the leading families. The other families had less than 7 species. Biological spectrum of flora indicated that therophytes followed by hemicryptophytes were dominant. Leaf spectra revealed that nanophylls, leptophylls, microphylls and mesophylls were the most prevalent leaf sizes. *Cuscuta reflexa*, *Capparis decidua, Periploca aphylla, P. calophylla* and *Equisetum arvense* were aphyllous species.

Phenological study indicated that March had the peak flowering season as 31.2% of the plants blossomed. The flowering species decreased towards winter. Peak fruiting was recorded in the month of April that gradually decreased toward dormant season. The major bulk of the flora 55.1% were in vegetative phase during the months of February and from October to December. The first dormant period had the majority of the species i.e. 57.2% from October to December while in the second spell 40.0% species remained dormant from June to August. Ethnoecological classification indicated that most plants were used as fodder (69.3%); other uses were medicinal (22.4%), fuel wood (17.6%), timber (5.4%), vegetables (4.4%), condiment (2.4%), roof thatching (5.8%) and furniture (1.5%).

There were 24 plant communities in six habitats during various seasons. Of them, (1) *Typha-Tamarix aphylla-Tamarix dioca* (2) *Tamarix-Suaeda-Typha* (3) *Desmostachya-Chenopodium-Acacia* (4) *Sonchus-Malva-Medicago* (5) *Saccharum-Citrullus-Tribulus* (6) *Arnebia-Psammogeton-Malcolmia* and (7) *Salvadora-Periploca-Withania* etc. were the representative and important communities. However, on the basis

of cluster analysis and DCA analysis the plants communities were grouped into 4 associations and 5 groups with one outlier. Woodland and herbaceous association, xero-sere herbaceous association, thorny woody association and degraded woody associations.

Edaphology revealed that the soil texture was mostly sandy and sandy clay with pH ranging from 7.8 - 8.6. Organic matter was less varied from 0.37 - 1.08 %. The EC was in between 0.13 dSm^{-1} and 3.45 dSm^{-1}. Nitrogen ranged from 0.023 - 0.068%, phosphorus and potassium had in between 2 - 5 ppm and 100 - 280 ppm respectively. Exchangeable sodium varied from 0.3 - 3.2 ppm.

Palatability study indicated that the ratio of palatable to total species was 1: 1.3 and non palatable to the total was 1: 3.7. Among the palatable species, 16.1% were highly palatable, 16.1% mostly palatable, 20.4% less palatable and 20.9% of the species were rarely palatable. Among the palatable species, 72 species were liked by sheep and 66 species by goat. Similarly, camel and cow respectively preferred 40% and 36% of the species. It was found that in 40% species shoots/ whole plants were used, in 29.7% species foliage/ leaves were used while only in 3.9% floral parts were consumed. Of the palatable species, 36.2% species were utilized in fresh condition and 29.5% in dry condition. The availability of fodder species during the year depended upon the season. There were 138 species available in spring, 100 species in summer, 78 species in winter and 76 species in autumn.

The total average herbaceous biomass productivity during spring was 869 Kg/h, in autumn 769 kg/h, in winter 408 kg/h and 291 Kg/h in summer. The total productivity for shrubs was 87546 Kg/h. Based on habitats the productivity was highest (35141 Kg/h) in waterlogged area followed by foothills (21155 Kg/h). Cultivated land was next in biomass production (17452 Kg/h). Dry land, sandy and wet habitats respectively provided 8620 Kg/h, 3181 Kg/h and 1997 Kg/h of biomass. Due to waterlogged and saline condition *Salsola* and *Suaeda* are growing well which possibly yielded high.

Eleven species were analyzed for macro and micro minerals in three phenological stages for Ca, P, N, Na, K and Mg and Zn, Mn, Pb, Cr, Cd, Fe, Ni and Cu. With few exceptions, generally increasing trend of concentration towards maturity of plants was observed. Similarly, DM, OM, CP, CF and ash concentration also increased toward maturity in herbs while, ether extract was high in woody species. It is concluded that

sufficient levels of micro - and macro nutrients and different energies were present in the investigated forage plants. Therefore, there is no need to supplement mineral and nutrients in feed to the ruminants of District Tank. However, these fodders species are under stress and need sustainable utilization for the longevity of the rangelands. Even so, further study is needed to search out the grounds of poor health and biomass of the ruminants, because nutrients alone could not be the only reason met the health and productivity in this regard.

Conservation assessment revealed that seventy plant species (37.4%) were found vulnerable, 64 species (34.2%) endangered, 38 species (20.3%) rare and a small portion i.e. only 19 species (10.2%) were infrequent due to excessive collection, over grazing and other human influences in the investigated parts of District Tank. None of the species could be declared as dominant which highlighted the miserable current situation of plant resources in the area

The investigated rangelands are less productive and need rehabilitation through ecological management. This would be possible with the participation of local communities and NGOs and government to make the plant resources sustainable. It is recommended that the government should provide conservation chance to this area for the improvement of vegetation and range conditions. There is a dire need to provide alternate source of energy to overcome the burden on the rangeland resources. The severely degraded sites be subjected to reforestation with suitable woody and herbaceous species.

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INTRODUCTION

INTRODUCTION

Tank is the southernmost district of Khyber Pakhtunkhwa province. It derives its name from the Pashto name TUKK, which means limit boundary. Tank lies on the boundary with South Waziristan agency. The Town of Tank was ruled by late Nawab Shah Nawaz Khan. It was made tehsil of District Dera Ismail Khan in 1878 and upgraded to the level of District in 1992. Tank is bounded by the districts of Lakki Marwat to the northeast, Dera Ismail Khan to the east and southeast, and South Waziristan to the southwest, west, and northwest. The climate in Tank reaches 110-120 °F, however in the cold, harsh winters of the mountains, people come to Tank to enjoy a pleasant stay and then resort back during the summer. It is located at 32°13' N. and 70°32' E and is situated to the north-west of the Indus River and close to the Takht-i-Sulaiman Range. The altitude varies from 260 to 300 meters above the sea level (Fig. 1).

History

The town was founded by Katal Khan, the first Nawab of Tank. The Imperial Gazetteer of India (written in the early 20th century) describes the town as, it stands on the left bank of a ravine which issues from the Tank Larn pass, 40 miles north-west of Dera Ismail Khan town. A mud wall surrounds the town, 12 feet in height and 7 feet thick, with numerous towers and two or three gates, but it is in bad repair. The fort, now in ruins, is an enormous pile of mud about 250 yards square. The walls, faced with back, enclose a citadel 40 feet high. It was the residence of a Nawab of Tank (Shah Nawaz Khan) from Katti Khel family, who formerly exercised semi-independent powers.

British rule

After defeating the Sikhs, Tank came under British control. Sir Henry Durand, lieutenant-Governor of the Punjab was killed in 1870 while passing through the area on an elephant. He was buried in Dera Ismail Khan. Dubbed as the Little England, this town is a staging point for most of the tribes of the region. During British rule, Tank was the Headquarters of Tehsil Tank, then a subdivision of Dera Ismail Khan District. The population of the town according to the 1901 census of India was 4,402. Tank was declared a notified area in 1893. The municipal income in 1903 - 4 was Rs. 11, 500, chiefly derived from octroi; and the expenditure was Rs. 9,100. Timber and ghee were brought down from the hills of Waziristan in considerable quantities, while the exports

included grain, cloth, tobacco, and other luxuries. The British negotiated with the tribes through their agents in Tank, which was a centre of negotiation with the Mahsud tribe through the influence of Nawab of Tank. For the Britishers the Mahsud tribe was the most difficult to control and in 1860 when the Mahsud attacked the British with a 3000 strong Lashkar the British were forced to penetrate into the territory of Tank to control them.

Culture and Society

The native villagers are mainly the farmers and field workers, who depended upon the flood waters to irigate their lands. Their water rights are stolen by the tribes' people living upstream. The northern settlers are Pashto-speaking people who make their livelihood by farming, land ownership, gun running, smuggling, falcon catching, and migration for employment to the Persian Gulf, or by ownership of shops and business in Tank. Jirga means *Council* which is the religious circles and or a group of people that decide the fate of the dwellers and rule the people by their indigenous laws and principles.

The Tribes and Administration

The natives belong to various Pukhtun tribes including the Katti Khel who were the ruler and chiefs (Nawab) of Tank, Bhittanis, Kundi, Mianis, Wazir's and the Mahsuds. The Nawab of Tank belongs to Katti Khel who was invaders from Afghanistan. The district contains one (subdivision) tehsil Tank.

Languages

The people speak Pashto. Tank city dwellers also speak Siraiky. The Burki tribe speaks Burki language.

Climate

The climate is semiarid. The winter is cold and bracing. The hottest month is June where the mean maximum and minimum temperature is 42^0C and 27^0C, respectively. The humidity is lowest during May and June. During these months the area is under periodic dust storms. The hot winds known as" Loos" blow across the district. The cold wave lasts from December to February which is the coldest months with severe frost. The mean maximum and minimum recorded temperature during January is 20^0C and 4^0C

respectively. The annual rainfall is about 226 mm that generally is received in July and August (Table 1).

Table 1. Climatic data of District Tank 2008

Year 2008	T	TM	Tm	SLP	H	PP	VV	V	VM	RA	SN	TS	FG
January	10.6	18.3	3.6	1017.7	57.2	5.34	5.7	2.6	10	5	0	1	2
February	14.1	21.6	7	1015.6	55.6	6.61	5.3	2.2	8.8	4	0	0	0
March	23.3	31.4	15.2	1009.2	54.1	0	5.9	0.9	6.6	1	0	1	0
April	25.7	32.8	18.4	1006.8	54.4	34.28	6.3	2.3	11.6	6	0	7	0
May	31.8	39.1	24.3	1000	45.4	16.76	5.4	1.4	8.4	0	0	2	0
June	33.2	39.4	27.1	995.6	60.6	31.5	4.6	2	9.8	3	0	2	0
July	32.3	37.8	26.5	995.7	68.8	104.9	5.4	1.9	9.9	3	0	4	0
August	30.7	35.6	25.3	998.6	74.7	120.14	5.9	0.7	9.2	5	0	4	0
September	28.8	34.9	22.4	1004	70.4	101.35	5.9	0.9	13	4	0	5	0
October	26.3	33.5	20	1010	63.6	0	4.6	0.5	7.8	0	0	1	0
November	18.8	28.8	10.6	1014.6	56.3	0	4.7	1.4	10.1	0	0	0	0
December	14.5	22.9	7.1	1017	70.1	15.49	3.7	0.8	8.6	3	0	0	4

Source: Meteorological report Dera Ismail khan, 2008.

Key:

T Mean temperature (°C), TM Maximum temperature (°C),Tm Minimum temperature (°C), SLP Mean sea level pressure (mb), H Mean humidity (%), PP Precipitation amount (mm), VV Mean visibility (Km), V Mean wind speed (Km/h), VM Maximum sustained wind speed (Km/h), RA Indicator for occurrence of: Rain or Drizzle, SN Indicator for occurrence of: Snow or Ice Pellets, TS Indicator for occurrence of: Thunder, FG Indicator for occurrence of: Fog.

Hydrology

Two rivers; Tank Zima and River Gomal are the perennial source of water flowing from South Waziristan hills irrigating small lands in the area. The government of Pakistan has initiated a Dam at the river Gomal called Gomal Zam dam. Its daily output is estimated as 22 MW electricity and providing permanent irrigation to more than 160,000 acres of alluvial silt plains. Other important hill-torrents are Sedgi, Shuza, Chaudhwan-zam and Draban etc. These hill torrents originate from the eastern slope of Shuza and South Waziristan hills.

Geology and Soil

Tank is surrounded by sedimentary rocks ranging in age from Permian and recent. The town of tank is underlined by a blanket of quaternary alluvium composed of unconsolidated conglomerate, sand and siltstone and loess. The Marwat ranges are dominated by sand stone, siltstone, shell and clay. The soil are mostly developed either from sub recent or old prominent plains. Soils are very deep silt, clay or clay - loam.

Agriculture and Horticulture

Due to semiarid dry nature a small portion of land is under irrigation. The area mostly depends on rain fall in winter as well as summer. The major crops sown are sorghum and millet in summer, melon and water melon in spring. While oil seeds, gram and wheat are the winter crops. Besides tomato, various other vegetables are grown in different seasons. Date palm (*Phoenix dactylifera)* and melon *(Cumumis sativus)* etc. are the common fruits in the area.

Flora and Fauna

The flora of Tank is generally xerophytic. The common tree vegetation is composed of *Acacia nilotica, Prosopis farcta, Zizyphus mauritiana* and *Tamarix aphylla*. The dominant shrubby flora consisted of *Salsola foetida, Prosopis cineraria* and *Suaeda fruticosa* while the *Saccharum spontaneum, Cenchrus ciliaris* and *Cymbopogon jwarancusa* etc are common bunch grasses. Quail, black and grey partridges, pigeon, crow, jackals, mice squirrels, snakes, lizards, hare etc. are common fauna of the area.

Population and Growth

The total population of Tank is 0.3 million (300,000) as enumerated in March 1998 (Census report) of which 95% live in rural areas. The annual growth rate is 3.1%.

The total area of District Tank is 1679 km^2 with a population density of 142 people/ km^2 as against 84 persons in 1981 which indicates the fast growth rate of the district.

Education

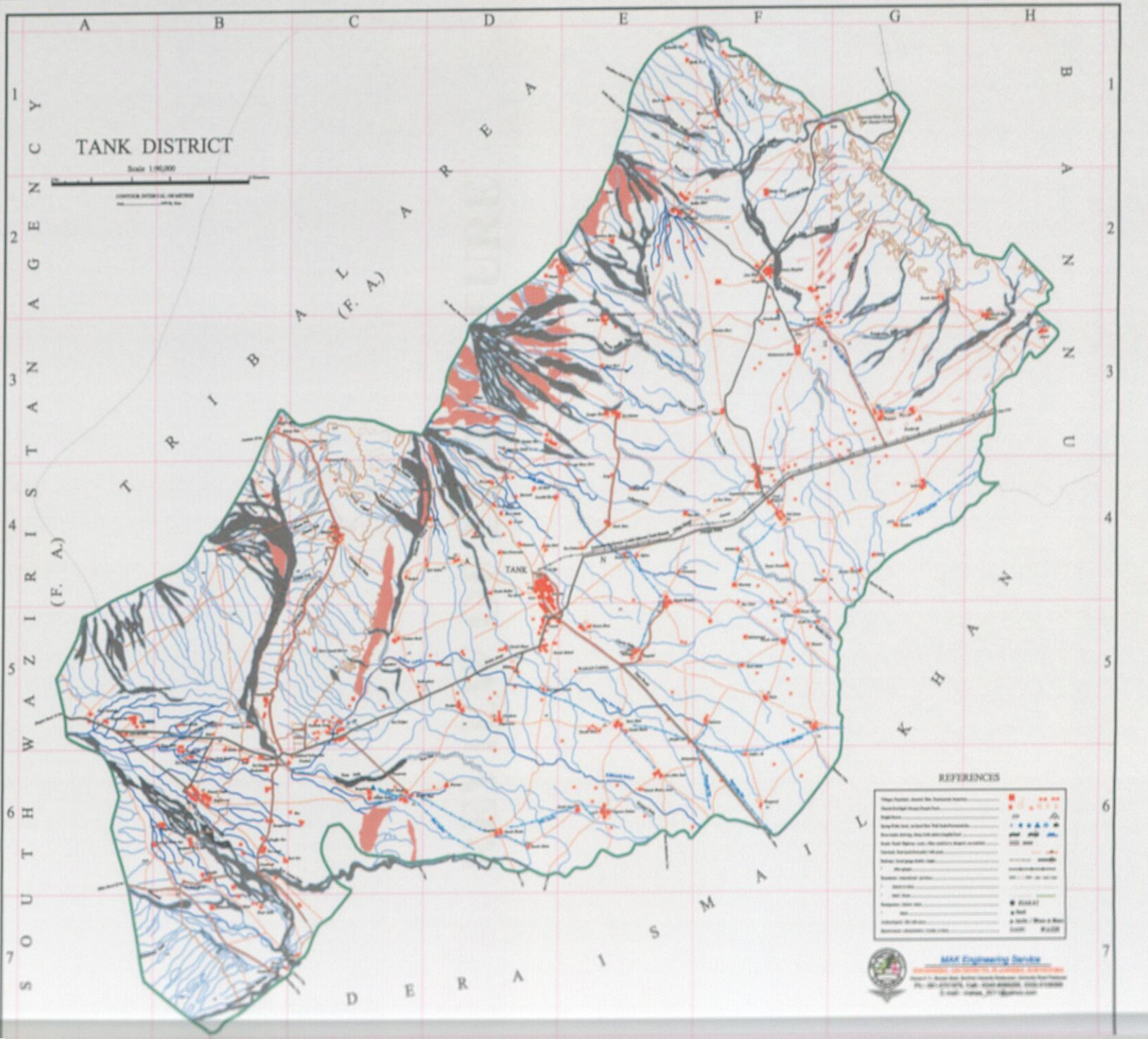
There are 4 colleges, 31 high schools, 42 middle schools and 345 primary schools educating the people in the area with many private educational institutions. The annual enrollment at primary level is 28% and 71% respectively for male and female.

Health

The people are facilitated with 1 hospital (16 beds), one Christian hospital (50 beds), 1 Maternal and child health, three Rural health centers, 16 Basic health units and four dispensaries by the government of Khyber Pakhtunkhwa province.



Fig. 1. Map of the research area.


TANK DISTRICT
Scale 1:50,000
SOUTH WAZIRISTAN AGENCY
TRIBAL AREA (F. A.)
BANNU
KHAIL
TANK
DERA ISMAIL
REFERENCES
MAK Engineering Service

REVIEW OF LITERATURE

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A. Floristic Composition and its Ecological Characteristics

Mark *et al.* (2001) while working on alpine zone at meso- and micro- scales in southern Tierra collected data on plant cover and life form. They stated that the richness of 80 local vascular taxa (18.6% of the regional flora), decreased with increasing altitude and also observed that chamaephytes and hemicryptophytes dominated throughout but microphenerophyte and megaphanerophtes were conspicuously absent.

Antje (2002) investigated the relationship between Inselberg floras in floristic and functional terms and their correlation with environmental variables at macro-scale and landscape level. He concluded that neither growth form nor dispersal spectra closely resembled the pattern that emerged in the ordination of floristic composition. The influence of geographical position lessened when functional rather than floristic measures were introduced in the analysis. Batalha & Martins (2002) worked on a wide physiognomic range, from grasslands to tall woodlands in Brazil. They compiled Raunkiaer's life-form spectra. They stated that in all Cerrado life-form spectra, the main life-form classes were the hemicryptophytes and the phanerophytes, the former prevailing in sites with open physiognomies and the latter prevailing in sites with closed physiognomies. The cerrado sites distinguished themselves from the savanna sites by their under-representation of therophytes. Gutkowski *et al.* (2002) recorded 69 species with geobotanical importance from Dynów foothills, Poland. It included 14 mountain species (7 montane, 6 multizonal mountain species and 1 sub-montane species) and 7 species not native to the area (3 archaeophytes, 1 epeokophytes, 1 apophytes, 1 hemiagriophytes and 1 of uncertain status). Kwiatkowski (2002) prepared a list of vascular plants from Kaczawskie Mounntains and Plateau in Western Sudety Mountains, Poland. Approximately 600 of the selected species, 160 rare, interesting and endangered taxa of vascular flora were found. Most of them were new. The species were found commonly distributed throughout the area. Luis *et al.* (2002) recorded 46 vascular plant species, 32 being emergent macrophytes, mostly Gramineae and Cyperaceae, five floating-leaved, three submerged, one surface-floating and also five shrubs. Cluster analysis of the floristic data showed two main groups of inventories in both seasons.

Antje *et al*. (2003) investigated the floristic composition of 14 mesas in southern African Nama Karoo along a latitude gradient. They stated that mesas can act as sources for re-colonization as well as havens for species adapted to mountain habitats and that mesa habitats were richer in species than plains in the northern These findings stress the importance for the protection of mesa habitats in view of increasing human pressure on mountain habitats. Changwe & Balkwill (2003) listed 254 taxa in 172 genera and 63 families from Dunbar Valley which has more species than other studied serpentinite sites in the Barberton Greenstone Belt (BGB). The genus *Senecio* was the most speciose genus in the BGB. The level of species endemism at Dunbar Valley was 2%. Dar & Christensen (2003) while working on the *Juniperus* reported 6 taxa from India. Seven taxa are recognized from the Western Himalaya in the present study: one belonging to *Juniperus* Sect. *Juniperus, J. communis* var. *saxatilis* and the other six to *Juniperus* Sect. *Sabina*. The latter section includes two acicular-leaved species, *J. squamata* and *J. recurva*, and four scale-leaved species: two multiseed, *J. semiglobosa* and *J. polycarpos*, and two monoseed, *J. wallichiana* and *J. pseudosabina*. Lehnebach (2003) reported a preliminary checklist of the orchids occurring in Chile which comprised of 7 genera and 50 taxa, 25 of which are believed to be endemic to Chile. Musila *et al.* (2003) described 156 plant species from coastal dune vegetation of Kenya. Sixty families were recorded with Gramineae (17 species) and Papilionaceae (16 species) being the most widely represented.

Eilu *et al*. (2004) recorded a total of 5747 trees in 53 families, 159 genera, and 212 species. Twenty-two families had one species each, while the rest had between two and 25 species. Number of species was highest in the family Euphorbiaceae (25 species) followed by Meliaceae and Rubiaceae with sixteen species each. Based on Rabinowitz's forms of rarity, 93% of the species were geographically widespread, 47% were restricted to a single forest type, while 41% occurred at densities of <1 individual ha $^{-1}$. Gimenez *et al.* (2004) worked on the flora and biodiversity of Iberian Peninsula which has 516 vascular endemic species or subspecies with an endemicity rate of 13%. This study dealt with species richness, originality, life forms and dispersal modes of these plants, in relation to altitudinal and rainfall gradients. Chamaephytes (46.08%) and hemicryptophytes (31.37%) were very abundant, whereas therophytes (11.96%) and

phanerophytes (0.98%) were comparatively rare. Chamaephytes reached their highest density rates within 1400–2000 m.

Golluscio *et al.* (2005) stated that both plant phenology and plant life form determine the ability to use resources. The phenological heterogeneity within and among life forms of a single community may reveal key features of community structure, such as temporal niche segregation within life forms or convergence of phenological and life form patterns. Grasses had higher autumn-winter phenological activity than non-grass groups which differed in the date of beginning of vegetative growth and ending of the reproductive growth. Mendez (2005) determined the flora of Laguna de Llancanelo Provincial Reserve that comprised of 240 species distributed in 156 genera and 52 families. Of them, one belonged to gymnospermae, 51 to angiospermae, 10 to monocotyledoneae, and 41 were dicotyledoneae. The best represented plant families are Asteraceae (Compositae) and Poaceae (Gramineae), affording 57 genus and 82 species, respectively. *Baccharis* and *Stipa* are the most abundant genera. The forms of life of each species and their distribution are consigned within the vegetation units, phytogeographic provinces, together with the degree of endemism. The flora is related to that of the province and that of the country. Muoghalu & Okeesan (2005) reported 49 climber species consisting of 35 liana (34%) and fourteen vine species (13.7%) distributed over 41 genera and 28 families. Climber basal area, density, number of species, genera and families increased with altitude. Forty-two per cent (42%) of the trees in the forest carried climbers.

Muthuramkumar *et al.* (2006) observed changes in tree, liana, and under story plant diversity and community composition in five tropical rain forest fragments in the Valparai plateau, Western Ghats. There were 312 species in 103 families: 1968 trees (144 species), 2250 lianas (60 species), and 6123 understory plants (108 species). Understory species density was highest in the highly disturbed fragment, due to weedy invasive species occurring with rain forest plants. Segawa & Nkuutu (2006) recorded 179 species belonging to 70 families and 146 genera from Lake Victotia Central Uganda. Of these, Rubiaceae was the richest with fourteen species followed by Euphorbiaceae (13 spp.), Apocynaceae (10 spp.) and Moraceae (9 spp.). Majority of the families (35) were

represented by one species each. Fifty-eight herbaceous species, 39 lianas, 10 shrubs and 72 species of trees were recorded.

Costa *et al.* (2007) listed 133 species belonging to 47 families. The herbaceous/woody ratio was 1: 4. The Raunkiaerean life-form spectrum observed was: therophytes (42.9%), phanerophytes (26.3%), chamaephytes (15.8%), hemicryptophytes (12.8%), and cryptophytes (2.3%). Laidlaw *et al.* (2007) examined local and regional variation in tropical rainforest and discovered that the most abundant families were Meliaceae, Euphorbiaceae, Lauraceae, Myrtaceae and Apocynaceae. The most abundant species were *Cleistanthus myrianthus, Alstonia scholaris, Myristica insipida, Normanbya normanbyi* and *Rockinghamia angustifolia*. Yadav & Gupta (2007) quantified the diversity of herbaceous species in relation to various micro-environmental conditions and human disturbance in the Sariska Tiger Project in Rajasthan, India. Several species sensitive to human disturbance have disappeared from the disturbed areas. The species diversity index in the undisturbed Slopka forest was 3.051, followed by the Kalighati forest (3.415) and the Bharthari forest (3.027). However, in the Hajipur forest, species diversity index was high (3.564), due to the increase in species richness. It is suggested that the rich species diversity of the herbaceous vegetation of the Sariska Tiger Project may be protected only by *in situ* conservation.

Francisco *et al.* (2009) published a checklist of Commelinaceae of Equatorial Guinea, comprising of 46 taxa in 12 genera. The best represented genus was *Palisota*, with 11 species. Eleven species of Commelinaceae were recorded for the first time in the country.

Manhas *et al.* (2010) reported a total of 206 species belonging to 159 genera and 59 families from Pathankot, Hoshiarpur and Garhshanker, India. The contribution of dicotyledons, monocotyledons and pteridophytes was 77.7%, 20.4% and 1.9%, respectively. *Ipomoea* was the most dominant genus. Biological spectrum of the study site showed that therophytes (52%) were the most dominant life form followed by phanerophytes (27%).

In Pakistan work on the floristic listing, composition and ecological characteristics has been done which is reviewed as follows.

Bhatti *et al.* (2001) identified 150 plant species of 110 genera and 42 families from Nara desert including one species of gymnosperm, 3 sedges and 20 grasses. Malik & Malik (2004) recorded 58 plant species, out of which 9 species were woody, 13 shrubby and the remaining 36 were herbaceous. The investigated data showed heavy deforestation and overgrazing.

Durrani *et al.* (2005) recorded 202 species of 45 plant families from Harboi rangeland Kalat. Asteraceae, Papilionaceae, Poaceae, Brassicaceae and Lamiaceae were the leading families. *Juniperus macropoda* was the only tree species. They also stated that the dominant life forms were therophyte and hemicryptophyte while nanophylls, microphylls and leptophylls were dominant leaf sizes. Some 83.6% plants flowered during April to June while 63.3% plants bloomed during July to September. Qureshi & Bhatti (2005) reported 160 plant species belonging to 118 genera and 45 families during floristic survey of Nara Desert Pakistan. Of them, they recorded one species of gymnosperm, three sedges and 20 species of Poaceae later on. Qureshi & Bhatti (2006) provided a floristic check list of 25 plant species including 3 monocot families from Nara Desert.

Perveen *et al.* (2008) reported 79 plants species from Dureji Game Reserve that belonged to 66 genera under 32 families, which also included three rare species. Phenology and quantitative analysis of species diversity and phytosociological attributes were recorded. Qureshi & Bhatti (2008b) reported five species of the genera *Anticharis, Bacopa, Kickxia* and *Schweinfurthia* from Nara Desert for the first time. They stated that since, these species are narrowly distributed; therefore efforts should be made to conserve them. Hussain *et al.* (2009) reported 69 plant species of 29 families from District Chakwal. The vegetation transects in 4 sites of the rangelands included 20 species of grasses, 12 of trees, 31 of shrubs and 6 of under shrubs and herbs. Durrani *et al.* (2010) evaluated floristic composition and its ecological characteristics in Aghberg range lands of Quetta Pakistan. The study showed that the protected sites supported 123 plant species belonging to 36 families, while unprotected sites had only 28 species. Asteraceae, Fabaceae, Poaceae, Brassicaceae, Lamiaceae and Boraginaceae were important families in the protected area.

In Khyber Pakhtunkhwa Province too some work on the floristic composition is available.

Marwat & Qureshi (2000) recorded 383 species of 110 families including 5 coniferous, 43 broad leaved trees, 56 shrubs and 279 herbs from Upper Siran reserved and guzara forests. Sher *et al.* (2003) reported 78 species under 37 genera of 47 families from Udigram. Of them 68 plant were dicotyledons, 6 monocotyledons, 1 gymnosperm, 2 pteriodophytes and 1 fungus. The largest family was Lamiaceae (9 species) followed by Asteraceae, Poaceae (each with 5 species), and Rosaceae (4 species). Hussain *et al.* (2005) reported 92 species of 56 families from Ghalegay Hills, District Swat. Of them, 49 families were dicotyledonous, 3 monocotyledons, 3 pteridophytic and one gymnospermic. Based on the number of species, Rosaceae (l0 Spp.), Asteraceae (6 Spp.), Lamiaceae (6 Spp.) and Poaceae (6 Spp.) were important families. But on the basis of FIV Pinaceae (267), Lamiaceae (244), Poaceae (167), Rosaceae (151), Papilionaceae (150), Acanthaceae (123) and Oleaceae (93) were important. Nanophanerophytic (33.6%) and microphyllous (46.6%) species were dominant.

Sher & Khan (2007) listed 222 plant species belonging to 88 families in Chagharzai Valley, District Buner. Of them, 78 families were Dicots; 7 Monocots and 3 Pteridophytes. Gymnosperms were represented by Pinaceae only. Asteraceae had highest number of species i.e. 21 species. Zabihullah *et al.* (2007) reported 279 species of 229 genera belonging to 81 families from Kot Manzaray Baba Valley District Malakand. It included 69 dicotyledonous families with 181 genera and 204 species. While 11 families were monocot with 54 species of 47 genera. The only gymnospermic family, family Pinaceae was represented by *Pinus*. Poaceae had the maximum genera and species.

Fazal *et al.* (2010) reported 211 species of 170 genera, distributed among 66 families from District Haripur. Of which, 5 species of 5 genera are Gymnospermic distributed among 4 families. Out of 66 families, 7 families are monocotyledonous having 26 species and 24 genera. Rests of the 55 families were dicotyledonous including 180 species and 141 genera. Saima *et al.* (2010) recorded 167 species of 139 genera from 65 families from Ayubia National Park Abbottabad. The included *Pinus wallichiana, Abies pindrows, Taxus wallichiana* and *Cedrus deodara.*

The review shows that no reference on the flora or its characteristics of District Tank exists. Thus there is need to report the flora and its characteristics from this remote area.

B. Phytosociology/Vegetation Structure

Tabanez *et al.* (2000) recognized four physiognomic units: (1) low forest, (2) bamboo forest, (3) high forest, and (4) mature forest in four Atlantic seasonal forests in southeastern Brazil. Tree density, basal area, and species diversity increased from low forest to bamboo forest to high forest to mature forest. Liana cover was highest in low forest.

Grillini *et al.* (2001) stated that the Chambura Gorge, Queen Elizabeth National Park (QENP), is completely covered by a forest which so far has not been exploited and whose species, composition and structure are barely known. None of the species reach their potential maximum height, as measured in other areas and in a typical rain forest. In the structural analysis no relationships were found between the diameters and heights of the observed trees, if considered all together. Luis *et al.* (2002) stated that inventories of floristic groups correspond to two main vegetation types and can be spatially arranged. In the deepest inner part of the lagoon, *Nymphaea lotus* is the most important species, while *Oryza longistaminata* dominates in the shallower part. In spite of the shallow depth, the middle of the lagoon remains uncolonized by macrophytes. The main factors limiting the colonization by plants of the lagoon seem to be the low mineral and nutrient content of the water and its low transparency. Mosugelo *et al.* (2002) assessed the changes in vegetation cover in northern Chobe National Park (Botswana) using aerial photographs. Coverage of woodland vegetation decreased from 60% to 30% between 1962 and 1998, while shrub land vegetation increased from 5% to 33% during the same period. During the study period, woodland has gradually retreated away from the river front. While riparian forest covered a continuous area along the riverfront in 1962, only fragments were left in 1998.

Claros (2003) observed changes in forest structure and species diversity throughout secondary succession at two sites in the Bolivian Amazon. Canopy height species diversity and basal area increased with stand age, indicating that secondary forests rapidly attain a forest structure. A total of 250 species were recorded of which 50

percent made up 87 percent of the sampled individuals. Species diversity increased with the lowest diversity in the canopy. The results of the correspondence analysis indicated that species composition varied with stand age, forest layer, and site. The species composition of mature forests recovered at different rates in the different forest layers, being the slowest in the canopy layer. Kennedy *et al.* (2003) investigated the relationship between grass species richness and ecosystem stability in the Kruger National Park. A total of 135 to 489 individual grasses were identified from 189 sites. After the drought had passed species richness, standing crop and percentage abundance recovered to 92.1%, 113.8% and 92.8% of their pre-perturbation values, respectively. The findings suggest that ecosystem stability may be negatively related to grass species richness in South African savanna grasslands. Salvatori *et al.* (2003) while studying the vegetation maps from 1979 and 1998 suggested that vegetation in 46% of the Reserve area was converted from shrub land to grassland, possibly as a result of fire and grazing pressure. A low density of rodents was recorded in all habitats except in areas of human activity.

Brown & Bredenkamp (2004) developed a structural classification of the woody component using species size (SPIZE) classes. A classification of the woody component done by using a TWINSPAN classification indicated that structural SPIZE classes could also be used to explain the spatial distribution of woody species within and between various plant communities. DeWalt & Chave (2004) examined the effects of soil fertility specifically by measuring the density and basal area of trees, lianas, and palms on two soil types differing in fertility at each site. Cocha Cashu and KM41 had higher tree basal area and AGB than La Selva or Barro Colorado Island. Although total stem density, basal area, and some biomass components differed significantly among forests, they seemed less variable than, species richness. Dondeyne *et al.* (2004) studied the soils and vegetation of woodland in South Eastern Tanzania in nine sites. Villagers identified 133 species of which only 56% were previously scientifically identified. Hurka (2004) analyzed plant species diversity and composition of life form categories in a tropical dry forest in Northwestern Costa Rica. The results documented 328 plant species in 79 families and 247 genera of grasses, herbs, shrubs, lianas and trees. Species richness was greatest after 15 years and decreased significantly in older plots. The number of non-woody species was highest after three years of succession. Patrick *et al.* (2004) carried

out the phytosocological study in Degeya, Lufuka and Mpanga forests in central Uganda to determine the regeneration, density and size class distribution of trees used for making drums. Diameter at breast height (DBH) of trees and number and species of seedlings, saplings and poles of six tree species were determined. Walpole *et al.* (2004) stated that the woodlands of the Masai Mara National Reserve in Kenya have suffered dramatic declines over four decades as a result of elephant and fire pressure. Thirteen woody habitats were identified on the basis of species composition, varying from species-rich closed thickets and forest to less diverse open grasslands. Yuming *et al.* (2004) described the density of Bamboo and its long history of being used for multiple purposes by various mountain communities in China. Yunnan as a landlocked mountain province in southwest China holds a great number of species in its natural bamboo forests.

Angassa (2005) studied the vegetation on the bases of yield and botanical composition of the herbaceous layer. The grasses *Cenchrus ciliaris, Chrysopogon aucheri* and *Panicum coloratum* were common or dominant in both encroached and non-encroached sites. The relative yield increased with non-encroached sites and varied at different altitude. Jorge *et al.* (2005) compared vegetation structure and species richness across a 56-yr chronosequence of six replicated age classes of dry tropical forest on the island of Providencia, Colombia, in the Southwest. They stated that woody species density reached a peak in stands from 32 to 56 yr old while rarefaction analysis showed that species richness increased linearly with stand age and was highest in stands 56 yr old or greater. Basal area and mean tree height were positively associated with age since abandonment, while sprouting ability showed a negative relationship. Karsten *et al.* (2005) determined the classification of 549 phytosociological relieves and gave 4 groups comprising of 39 plant communities. With decreasing moisture appeared desert steppes with *Stipa glareosa* and *Allium polyrrhizum* and the desert steppe were mixed with lot of semi-desert scrub sparse dwarf *Anabasis brevifolia, Salsola passerina, Zygophyllum xanthoxylon* and *Haloxylon ammodendron*. Prakash (2005) stated that the density of threatened medicinal plant species varied with protected areas. The Valley of Flowers protected area had the highest number of threatened medicinal plant species. The "moist" habitat type was richest in these species among all 10 habitat types sampled. *Arnebia*

euchroma and *Ephedra gerardiana* were the most common threatened medicinal plant species.

Costa (2006) while studying the herb richness and abundance in Central Amazonia stated that climate and soil fertility affect under storey density and diversity at large scales. Herb richness, diversity, density, and cover increased with altitude and slope. The unexpected results of higher abundance and richness of pteridophytes in slopes, instead of in bottomlands, suggest that biotic or litter-mediated controls may be important to set these patterns. Dharani *et al*. (2006) investigated the woody vegetation of Lake Nakuru National Park along rivers, lakeshores and flood plains. Four different sites within the *Acacia xanthophloea* woodlands were selected for the study. Vegetation structure was not significantly different in the four woodlands, but these sites differed in the relative density of *Acacia* trees. Regeneration of *A. xanthophloea* differed in each site, with the highest regeneration rates found in the nonfenced plots where browsing took place. Fleischmann *et al*. (2006) while studying the species composition of the forest revealed little change in forest structure, species diversity and regeneration in the permanent plots over the 13-year period, but some regeneration of most woody species, presence of some alien species and a relatively high species turnover. Although the stand characteristics seemed to be relatively stable. Frances & Shahroukh (2006) evaluated the forbs communities of Kopjes (rock outcrops) in the Simba, Maasai and Loliondo areas of the Serengeti National Park. Species diversity measures and multivariate ordination techniques were used to examine the community similarity and species turnover between sites. Species turnover was very high in grassland habitats. Gould *et al*. (2006) quantified the species composition, diversity, conservation status, and ecological attributes of eight mature tropical forest plants. There were 374 species; 92% were native, 14% endemic, and 4% critical elements (locally endangered) to the island. The lowland moist forest communities, occurring within a matrix of urbanization, agriculture, and disturbance, had the highest degree of invasion by exotics. Community descriptions were nested within a variety of hierarchies to facilitate extrapolation of community characteristics to larger ecosystem units. Lovett *et al*. (2006) recorded a total of 2143 woody stems of ≥3 cm dbh from 204 species from Mwanihana forest. Species diversity was highest at high elevations. There was no clear zonation of elevational vegetation types. Maestre *et al*.

(2006) conducted a microcosm experiment to evaluate individual plant and whole community responses to species richness, species composition and soil nutrient heterogeneity. Communities containing *Plantago* and *Lolium* responded to nutrient heterogeneity by increasing above- and below-ground biomass. Nutrient heterogeneity also increased size inequalities among individuals of these species. Zheng *et al*. (2006) estimated the average density of large trees (DBH ≥100 cm) was 9.4 stems/ha on two small plots and 3.5 stems/ha on two large plots, illustrating the potential to overestimate biomass on a landscape scale if only small plots are sampled. Biomass estimations are similar to typical tropical rain forests in Southeast Asia and the Neotropics.

Devineau & Fournier (2007) assessed the preference of species in relation to various ecological factors. They compared the methods by comparing the "ecological" and "phytosociological" affinities of each species. A procrustean co-inertia analysis made it possible to calculate the distance between the "ecological" and "vicinity" co-ordinates of each species as a measurement of the correspondence between its ecological and sociological affinities. Thus, it was determined whether the species habitat was accurately characterized by the descriptors studied. Mohandass & Vijayan (2007) inventoried a total of 2279 stems belonging to 83 species, 68 genera and 40 families. Of these, 16 species from 12 genera and 12 families were lianas. About 30% of the species were endemic to the Western Ghats. Species diversity measured by Fisher's alpha index was 13.15 for trees and 4.54 for lianas, and basal area was 62 m^2 ha-1 for trees and 0.58 m^2 ha-1 for lianas. Tripathi & Shukla (2007) selected two grassland communities of Gorakhpur, one on the managed and protected site and the other moderately grazed, open natural site of University campus for the comparison of various vegetation parameters. Out of the total 100 species, 65 were common to both sites, 9 species occurred exclusively at site I and 26 species at site II. *Cassia absus, Cassia tora* and *Hyptissu aveolens* were rare in abundance at managed site while *Coccinia indica* and *Crotalaria ferugenia* were rare at natural site. Wahab *et al*. (2008) sampled vegetation structure, age and growth in 5 places of Dangam District of Afghanistan. Vegetation compositions of non tree species were also presented. On the basis of floristic composition and importance value index of tree species, two monospecific and one bispecific communities were recognized in the study area. It is shown that in *Picea smithiana* (Wall.) Boiss dbh, age and growth rates were not

significantly correlated. Lack of tree seedlings indicated poor regeneration status of the forests.

Guo *et al*. (2009) worked on the, the biological spectrum and hierarchical-synusia structure of *T. sutchuenensis* community. There were 73.2% phanerophyte, 18% hemicryptophyte, 6% geophyte, 2% chamaephyte, and 0.8% annual plants. The dominant leaf size was microphyllous (60.8%), and dominant leaf form was simple (86%).

Digiovinazzo *et al*. (2010) assessed the phytosociological relationship between a pool of woodland indicators and features of forest fragments in Italy, and evaluated whether ecological thresholds might provide guidelines for conservation. The number of forest indicators increased until 35–40 ha; above this size the richness remained constant. The identification of two thresholds in the relationship between patch area and indicators suggests an abrupt response to changing landscape features and provide quantitative targets for conservation. Adam & Crow (2010) using TWINSPAN analyzed the abundance and frequency data recorded from 106 study plots. Six cover types (CT) were defined: *Pinus strobus–Gaylussacia baccata* CT, *Fagus grandifolia–Ostrya virginiana* CT, *Pinus resinosa–Gaylussacia baccata–Vaccinium angustifolium* CT, *Tsuga canadensis* CT, *Acer rubrum–Dulichium arundinaceum* CT, and Ruderal CT. Sorensen's Index showed a 50.0% similarity with Bear Island, 51.1% with Rattlesnake Island, and 52.7% with Three Mile Island. The Simple Matching Index showed higher levels of similarity.

In Pakistan the studies made on vegetation structure and phytosociology is reviewed below.

Peer *et al*. (2001) reported about 100 plant taxa which were rated according to their morphological and functional features from Hindu Kush and Karakorum Range. Based on microclimatic and phytomass data, three types of "steppes" (1) The open semi-desert-steppe; (2) The more mesophyllous steppe and (3) The thorn cushion-steppe were recognized.

Malik & Malik (2004) recorded seven plant communities viz *Adiantum-Olea*, *Acacia modesta*, *Dodonaea-Acacia- Themeda*, *Pinus-Themeda*, *Imperata-Pinus*, *Pinus roxburghii* and *Pinus-Carissa-Themeda* recognized from Kotli Hills during monsoon, 2000. The vegetation belongs to Chirpine forest type.

Based on floristic composition and importance value, 24 communities and 4 monospecific forest vegetations were re cognized in Himalayan forests of Pakistan by Ahmad *et al*. (2006). Many communities showed similar floristic composition; however, they differed in quantitative values. Malik & Hussain (2006) stated that characteristic plant species of each community type are presented together with the information on dominance and sub-dominance species. Four plant communities were recognized. Classification and ordination techniques provided very similar results based on the floristic composition. The results formed the basis for the mapping spatial distribution of vegetation communities using image analysis techniques. Peer *et al*. (2007) studied the vegetation of the eastern Hindu Kush Mountains by two-way indicator species analysis (TWINSPAN) for hierarchical classification of community data, and canonical correspondence analysis (CCA) for examining relationships between the vegetation and selected environmental parameters. They established four communities (1) the desert steppe; (2) the *Artemisia brevifolia* steppe, (3) the alpine scree vegetation, and (4) the alpine mats. Perveen & Hussain (2007) conducted phytosociological and phenological status of plants i.e. flowering and fruiting condition in Gorakh hill Dadu district. Quantitative analyses on species diversity in addition to phytosociological attributes analysis were conducted. Some ecological parameters such as, life forms, species density, species cover, species relative density and frequency were calculated.

Ahmad *et al*. (2008a) recorded the vegetation data during all the four seasons (autumn, winter, spring and summer) using quadrat method in Knotti Garden and Dape Sharif. Soil physical and chemical properties of each site had their own impacts on the species association. Most of the herbaceous species were frequent during summer and autumn due to suitable temperature and availability of moisture and nutrients. However, during winter sparse vegetation did not show grouping of plants due to severe cold temperature. Ahmad *et al*. (2008b) revealed that among the woody leguminous plants *Acacia modesta* was the most commonly occurring species in Soone Valley, Punjab, Pakistan. *Prosopis juliflora* occurred very commonly and formed mono-species stands, while *Dalbergia sissoo* was absent altogether. Among the herbaceous weedy legumes *Medicago polymorpha* and *Melilotus indica* were commonly found during the winter seasons. At higher altitudes *Olea ferruginea* formed a good association with *Acacia*

modesta. Throughout the examined site, *Dodonaea viscosa* and *Justicia adhatoda* occurred very abundantly, because both species had resistance for grazing and fuel needs. Arshad *et al*. (2008) analyzed vegetation types for density, frequency, and cover and importance value index in rangelands of the Cholistan desert. The association of certain plant species to certain soil types was common indicating the influence of chemical composition of the soils. The result showed marked important relationships between soil characteristics and plant species. *Suaeda fruticosa* and *Haloxylon recurvum* the high salinity levels and low organic matter. *Calligonum polygonoides, Aerva javanica, Dipterygium glaucum, Capparis decidua* and *Haloxylon salicornicum* indicated better organic matter. Perveen *et al*. (2008) worked on the quantitative analysis on species diversity in addition to phytosociological attributes in Dureji game reserve. Some ecological parameters such as life form, density, relative density, cover, relative cover frequency and relative frequency were investigated. Vegetation cover varies from place to place depending upon the texture and structure of the soil. Vegetation structure and density was greatly influenced by the rainfall. One of the main threats to the vegetation of the study area is grazing. Malik & Hussain (2008) worked on the phytosociology in the Lohibehr scrub forest in the Foothills of Himalaya, northeast of Pakistan. The objective of the study was to find out the relationship between remote sensing data and vegetation communities of ecological importance using multivariate techniques such as (TWINSPAN), (PCA) and Correspondence Canonical Analysis (CCA). The results highlighted the potential of remote sensing data in providing information on different plant community types that could be used in planning, management and conservation of subtropical forest. Qureshi (2008) worked on the vegetation parameters like cover, frequency and density by quadrat method in Sawan Wari of Nara Desert. They recognized five plant communities based on Importance Value. 1) *Phragmites- Typha-Saccharum* in wetland; 2) *Calligonum-Dipterygium-Salvadora* in desert; 3) *Saccharum-Pluchea-Typha* in marshland; 4) *Desmostachya-Brachiaria-Cynodon* in agricultural habitats and 5) *Salvadora-Desmostachya-Prosopis* in protected forest. Wazir *et al*. (2008) identified 5 vegetation types viz., crassulescent steppes, chamaephytic steppes, erme, moist sub-alpine pastures and riverine pseudo-steppes in Chapursan Valley, Gilgit on the basis of topographic and edaphic heterogeneity.

Hussain & Perveen (2009) evaluated the plant biodiversity and phytosociological attributes of the Tiko Baran, Khirthar range Dadu district. Phenological status of each species i.e. flowering and fruiting conditions were also observed. Quantitative analysis on species diversity in addition to phytosociological attributes analysis was conducted. Some ecological parameters such as life forms, species density, species cover, species relative density and frequency were calculated. Hussain *et al*. (2009) stated that plant density, frequency and cover in Chakwal varied among grasses, trees and shrubs across the three growth seasons. There was highly significant difference in grasses, trees and shrubs in all four range sites. Flat areas had highest plant density as compared to sloping areas and nullah beds/channels respectively. In spring and summer, same trend was observed in flat areas that exhibited highest plant density as compared to other range.

Ali & Malik (2010) assessed the vegetation communities of the open urban spaces viz., green belts, gardens and parks of Islamabad city. TWINSPAN classified the floristic species composition into four major community types which showed some overlap in an ordination space, reflecting relatively homogenous nature of the vegetation. *Pinus roxburghii* and *Grewia asiatica* were more prevalent in green belts while native vegetation dominated by *Dalbergia sissoo* and *Acacia nilotica ssp. nilotica* were present in undisturbed green spaces. *Broussonetia papyrifera* and *Populus euphratica* showed distribution along the drains/nullahs in the city. Ahmad *et al*. (2010a) recognized two major and sixteen sub-communities along 358 km long motorway. TWINSPAN divided the vegetation of whole study area into 2 major communities, which were further divided into 16 sub-communities. The study also provides basic information for the implementation of conservation oriented planning and management to preserve and improve the road verges of M-2. Recently Ahmad *et al*. (2010b) presented a review of work on the vegetation of Pakistan. Siddiqui *et al*. (2010) examined quantitative vegetation description of moist temperate coniferous forest of Himalayan region of Pakistan. They separated three groups on ordination. Group 1 was dominated by *Pinus wallichiana* stand, group 11 by *Abies pindrow* and 111 was that of *Cedrus deodara*. Akbar *et al*. (2010) identified seven plant communities which included *Luffa echinata, Populus euphratica* and *Tamarix sarenensis* in Keenjhar Lake District Sindh. Nawaz *et al*. (2010) stated that vegetation (tree) cover is about 60%. Plant diversity was

astonishingly high over 140 species. There was a significant difference in vegetation structure between protected and non protected area.

In Khyber Pakhtunkhwa the phytosociological work is summarized as follows:

Hussain *et al.* (2005) classified seven plant communities from Ghalegay Hills, District Swat into subtropical semi-evergreen forest, subtropical pine forest and blue pine temperate forests. Ahmad *et al.* (2009b) analyzed the vegetation along Abbottabad roadsides by using multivariate analysis techniques *i.e.* (DCA) and (CCA) in vegetation. A total of 63 plant species and 5 major communities were recognized along 5 major roadsides as demarcated by DCA and CCA. This relationship was determined by CANOCO analysis. The most important factors influencing the roadside vegetation were found to be lead and copper, and zinc to some extent. This study provides the basic information to preserve and improve the roadside vegetation, for reservation of native flora. Jabeen & Ahmad (2009) while working on vegetation of Ayub National Park classified the vegetation data with TWINSPAN. It resulted in species dichotomy, represented by two major communities. Deterended Correspondence Analysis (DCA), results indicated the presence of four major plant communities. Shah & Hussain (2009) analyzed 5 plant communities, each having its own species composition in Hayat Abad, District Peshawar. The richest families in number of species were Asteraceae, Brassicaceae, Poaceae and Solanaceae. Life form and leaf size spectra were also determined. Therophytes (48%) and cryptophytes (19%) were dominant in all stands. Similarly, microphyllous (40%) and leptophylls (22%) species were dominant.

Ahmad *et al.* (2010c) reported that the vegetation of the selected graveyards was comparatively less disturbed and the floristic composition was different from elsewhere due to religious sanctities in Upper Swat. Wahab *et al.* (2010) conducted a phytosociological study by quadrat method and sampled twenty five forest types in Distict Dir. Parameters like frequency, density, basal area and importance values were evaluated for establishing communities.

The following few papers on phytosociology of South Waziristan Agency are available.

Hussain & Badshah (1998) reported that the vegetation, life form, leaf size of south and north slopes differed at similar at altitude in Pirghar hills South Waziristan

agency. They reported that original woody species are present on the hills as isolated individual due to degradation. There is need for restoration of habitat. Badshah *et al.* (2010a) investigated phytosociological parameters and edaphic feature of vegetation of Tabai during autumn. There were differences in air and soil temperature due to similar elevation. There was a great difference in biomass production for various stands. The original vegetation structure has been altered due to deforestation and over grazing. There is a need for restoration of the habitat

The existing available literature shows that no reference on the phytosociology and vegetation structure of District Tank can be retrieved. Therefore, there is a dire need to work out the phytosociology and vegetation of the area.

C. Ethnobotany

Kappelle *et al.* (2000) reported a total of 590 species from Costa Rican Montane. Of them, 23.8% of 189 useful plant species were used for medicinal purposes, 39.7% for food, and 24.3% for construction and equal amount as fuel wood. Less important uses included dye, ornamental fodder, gum, oil, and poison. A total of 61.9% of the plants were used for one purpose only. Mathooko & Kariuki (2000) while working on the distribution of riparian vegetation of Montane reported *Juniperus procera-Olea europaea spp. africana* and submontane *Acacia abyssinica* forests were identified as the main riparian vegetation groups. Approximately 55% of the riparian vegetation species are used for herbal medicine, treating more than 330 health problems, and only 11% of the plants were edible. Macia (2004) reported 37 palm species used by the Huaoranis in Huaorani in Amazonian Ecuador. One hundred and ninety-one different uses were recorded in eight ethnobotanical categories. Most species (64.9%) were used for house construction and human food. More than half of the species were used for domestic utensils (59.4%) and hunting and fishing implements (54.6%). Tardío *et al.* (2006) compiled a total of 419 plant species belonging to 67 families in Spain. A list of species, plant parts used localization and method of consumption and harvesting time is presented. Of the seven different food categories considered, green vegetables were the largest group, followed by plants used to prepare beverages, wild fruits, and plants used for seasoning, sweets, preservatives, and other uses. Arenas & Scarpa (2007) reported that Chorote people use 57 plant species as a source of food, which they consume in 118

different ways. A cross-cultural comparison with four neighboring ethnic groups reveals that one third of their plant foods are exclusive to the Chorote people, despite the fact that they share most of their edible plants with the other groups. Mizaraite *et al.* (2007) examined the possibilities of increasing the use of wood from private forests in Lithuania for bioenergy purposes. Potential wood fuel supply and consumption were investigated using a literature review and analysis of statistical data. Costs of wood chips production were calculated applying economic simulation. Okello & Ssegawa (2007) carried an ethnobotanical survey in Ngai subcounty in Apac District and stated that roots were the most commonly harvested parts which have greatly affected the regeneration of medicinal plants. It was believed that plants collected only from the wild were effective. Though not intentional, plant parts not used for medicinal purposes are sometimes destroyed in the process of harvesting.

Miah *et al.* (2009) showed that family size, income, amount cooked and burning hours significantly affected the amount of wood fuel used per family per year in Bangladesh. Taking into account different family sizes, the study observed that 4.24 tone fuel woods were consumed per family per year. The main source of biomass fuel was homestead forests (40%). Mao *et al.* (2009) highlighted the rich plant resources and the vast wealth of ethnobotanical information available with the various tribes of the region. A brief review of ethnobotanical and traditional knowledge system reports published by various workers from the region is given. It also highlights some important medicinal plants and its status in the wild and also discussed on the need for harnessing the rich bio-resources and translating it to economic products. Meena & Yadav (2010) reported that the people of Rajasthan including Chittorgarh, Udaipur, Banswara and Dungarpur districts and their medicine men and women have valuable information about properties and medicinal uses of plants. They documented 31 species, belonging to 31 genera and 22 families.

In Pakistan the ethnobotanical studies are reviewed as follows:

Gillani *et al.* (2003) listed 54 medicinal plant species from Parachinar Kurram agency which had various local uses. Most of them were reported as first aid for stomach diseases. They also reported that during winter, almost all the people in the project area

used Afghan fuel wood. Average daily fuel wood consumption in the area was 60 kg/household/day.

Hussain *et al.* (2004) observed that eleven species were used for various timber purposes in South Waziristan Pakistan. *Populus afghanica, Cedrus deodara,* and *Pinus wallichiana* were decleared as the best timber wood in the area. Elder and illiterate respondents were more knowledgeable than young and educated ones. Wazir *et al.* (2004) listed a total 41 species, belonging to 29 families of an ethno-botanical importance from in Chapursan Valley District Gilgit. The main objective of this paper was to enlist the wealth of medicinal plants. Many wild herbs, shrubs and trees, were found to be used as medicinal plants by the inhabitants in the valley.

Jabbar *et al.* (2006) described 29 species including *Lamium amplexicaule* L., *Mallotus philippinensis, Withania somnifera, Azadirachta indica* and *Citrullus colocynthis* to treat helminthosis in ruminants from southern Punjab, Pakistan.

Ishtiaq *et al.* (2007) reported that *Solanum miniatum* is used to cure urinary calculi, heart pain, rheumatism, *Momordica balsamina* leaves as wound healer; *Allium sativum* bulb juice as anti cancer, contraceptive, blood pressure; *Boerhavia diffusa* roots as anti jaundice, anemia, edema; *Capsicum annuum* fruit as omen against evil eye and giant, yellow fever; *Corriandrum sativum* seeds etc as diuretic, anti spermatogenesis; *Raphanus sativus* seeds against syphilis. Khan & Khatoon (2007) observed that in Bugrote Valleys in District Gilgit 48 species of trees and shrubs were used in everyday life for medicine, shelter, agricultural tools and fuel. The population of the region primarily depends upon plant resources for their domestic needs. However, some plants are cultivated for these purposes.

Hussain *et al.* (2008) reported 49 traditional recipes, with 41 plant species representing 39 genera and 27 families from District Sahiwal for the treatment of helminthosis in animals. Qureshi & Bhatti (2008a) evaluated 51 plant species distributed across 28 families and 43 genera to have medicinal uses by local inhabitants of the Nara Desert. Twenty-one of these species are proposed to have new uses not recorded in the Indo-Pak folk herbal medicinal literature. Boraginaceae and Amaranthaceae were the most dominant families.

Sardar & Khan (2009) reported 102 species belonging to 93 genera and 62 families fromTehsil Shakargarh, District Narowal, which are being used by local inhabitants as fuel, furniture, fodder, making baskets and mats, brushing teeth, medicinal, vegetables and edible fruits.

Ajaib *et al*. (2010) reported 38 species of 36 genera belonging to 25 families from District Kotli, Azad Jammu & Kashmir, Pakistan, of economics importance. The local inhabitants used them as medicinal, fuel, shelter, and fodder/forage and in making agricultural tools. Most of the shrubs were noticed having more than one ethnobotanical uses. Tareen *et al*. (2010) observed that 61 species of medicinal plants belonging to 56 genera of 34 families from Kalat and Khuzdar, Baluchistan are traditionally used as medicines by the women for treatment of various diseases. Maximum number of species belongs to family Lamiaceae (9 species) followed by Asteraceae (7 species), Apiaceae, Papilionaceae (Leguminosae), Solanaceae and Zygophyllaceae (3 species each). Qasim *et al*. (2010) reported 48 wild coastal plant species from 26 families used in Hub, Lasbela District, Baluchistan for 12 different purposes. Plant uses included fodder (56%), medicine (22%), food (5%), household utensils (5%), for increasing milk production in cattle (3%) and other uses (8%). Most frequently used species were from Poaceae (29%) followed by Amaranthaceae & Chenopodiaceae) (10%), Mimosaceae and Convolvulaceae (6%).

In Khyber Pakhtunkhwa the ethnobotanical studies done are summarized as follows:

Ahmad *et al*. (2004) reported that the local people of Galliyat areas District Abbottabad preferably use medicinal plants for treating their common ailments by traditional methods. They reported a total of 41 wild plant species of 40 genera and 33 families used by local inhabitants for medicinal purposes. Wazir *et al*. (2007) reported 20 medicinal halophytes plants of 18 families found in District Karak and its surrounding. These medicinal are wide spread and are common up to Bahadar Khel salt range. Manan *et al*. (2007) stated that in Upper Dir 52 plants belonging to 35 families were used for different diseases that have significant role in the primary health care of area. Shah & Hussain (2008) reported 76 plant belonging to 52 families were used for various purposes Mount Elum District Bunir. The species include 47 % medicinal plants, 21 % fuel wood,

9 % fruit species, 19 % honeybee species, 20 % timber yielding species and 4 % poisonous species. Kamal *et al*. (2009) concluded that 50 plant species of 30 families are used medicinally and for other purposes in District Bannu for curing various diseases including cough, diarrhea, dysentery, constipation and stomach problems etc. Zahoor *et al*. (2009) enumerated the traditional uses of 52 plant species belonging to 45 genera and 30 families from Darra'e Pezo District, Lakki Marwat, Pakistan for various purposes. Out of the 52 plant species, 47 were medicinal. Some of useful species are under serious threat due to unsustainable activities. Khan *et al*. (2009) reported that 50 plant species are being used locally for medicinal and other purposes in F.R. Bannu. The largest families are Poaceae and Moraceae each with 5 species. *Agaricus campestris* was the only fungus used as food. Akhtar & Begum (2009) recorded that 55 plants belonging to 38 families were used for more than 42 ailments in Jalala area District Mardan. *Calotropis procera* and *Boerhavia diffusa* had multipurpose medicinal uses. The information reported is purely based on the knowledge of local inhabitants without any scientific authentication. Taj *et al*. (2009) revealed that ethnobotanically 29 plants species of 25 families were used for medicinal purposes in Godi Khel District Karak. Hazrat *et al*. (2010) conducted an ethnobotanical research in Usherai Valley and recorded 50 species, belonging to 32 families of wild herbs, shrubs and trees which were used as medicinal plants by the inhabitants in the valley. Attaullah *et al*. (2010) identified 27 species belonging 19 families that are being used in traditional health care of Kurram River beds of District Bannu. The use of these plants was confined mostly to less educated and poor people. However, some plants are also used by local Hakims. Badshah *et al*. (2010b) reported 41 species with various local uses from Parachinar Kurram Valley.

In Waziristan some work has been done on ethnobotanical aspect as follows:

Hussain *et al*. (2004) observed that eleven species were used for various timber purposes in South Waziristan Pakistan. *Populus afghanica, Cedrus deodara* and *Pinus wallichiana* were declared as the best timber wood in the area. Elder and illiterates were more knowledgeable than young and educated ones. Hussain *et al*. (2006) reported 67 species belonging to 40 families from South Waziristan Pakistan used in traditional healthcare system. *Morchella esculenta, Mentha longifolia, Thymus serpyllum* and *Citrullus colocynthis* etc. were the most important medicinal plants in the area. The

traditional medicinal knowledge was confined mostly to elderly and less educated people. Badshah *et al*. (2006) evaluated 26 species of 19 families including 7 shrubs and 19 trees used as fuel wood in South Waziristan Pakistan. *Quercus baloot*, *Olea ferruginea* and *Monotheca buxifolia* were ranked as the best species by 100% of the respondents. Badshah & Hussain (2008) observed that 20 plants species belonging to 20 genera of 18 families of medicinal importance in Village Tabai, South Waziristan, Pakistan. Ten species are affectively used for women diseases like, excessive menstrual flow, stop menses and for tightening the flagged breast. The remaining 10 are for curing different diseases in child. The review suggested that no work is reported from District Tank that necessitates the importance of such area.

D. Palatability of Vegetation

Karki *et al*. (2000) compared the community structure, nutritive quality and above ground biomass of grazing lawns to neighboring grasslands in the Terai of western Nepal. Grazing lawns differed from the adjacent grasslands in species composition and community structure. Lee *et al*. (2000) determined the effects of natural and artificial herbivory on plant fragments. Effects of real and artificial herbivory ranged from strong to no effects depending on the plant species and biotic conditions. Insect-damaged fragments showed stronger effects than artificially damaged fragments. Herbivory may be an important predictor of mortality in reproductive fragments of under story plants. Watson & Smith (2000) observed that browse contributed 94% to the annual diet of eland. The annual proportion of grass in eland diet was low (6%), even though palatable grass species were abundant in habitats favored by eland. Most grasses were eaten in the early wet season when grasses offered young green foliage. Woody species comprising dwarf shrubs and shrubs made up the bulk of the food eaten by eland.

Angassa & Baars (2001) investigated 41 grasses, 4 legumes, 3 sedges and 28 tree and/or shrub species. *Aristida adscensionis, Cenchrus ciliaris, Chrysopogon aucheri* and *Panicum coloratum* were common or dominant in all sampled areas. *Pennisetum mezianum* and *Pennisetum stramineum* were typically found in the encroached vegetation. Wassenaar & Aarde (2001) stated that the effects of grazing were apparently subordinate to site-specific intrinsic vegetation change and there were some indications that rainfall interacted with grazing level. Grazing had some apparent but no significant

effects on plant species composition, significantly affected plant species richness over time, and significantly increased the range of species richness and vegetation cover.

Brits *et al.* (2002) concluded that on average 3 % of the total area of the Kruger National Park (KNP) is affected by large herbivores congregating around artificial watering points. It was concluded that artificial water and the accompanying grazing and browsing gradients play a major role in the decline of large trees in the KNP. Mapfumo *et al.* (2000, 2002) stated that grazing intensity affects the litter and root mass, C and N pools of perennial grasses, smooth brome grass (*Bromus inermis*) and meadow brome grass (*Bromus riparius*) and the annual grass, winter triticale (*Tritico secale*).

Hickman *et al.* (2004) stated that native plant species diversity, species richness, and growth form diversity were significantly higher in grazed compared to ungrazed prairie, and diversity was greatest at the highest stocking density. This enhancement of plant species diversity under grazing was not a result of increased frequency of weedy/exotic species. Lucas *et al.* (2004) evaluated that increased grazing pressure did not have significant impact on cottonwood populations. Effect of seasonal use were significant on both herbaceous species richness and diversity. Grazing treatments appeared to have been successful at maintaining riparian communities. Mapinduzi *et al.* (2004) assessed that calf-grazing pastures had greater herbaceous species richness than the non-calf pastures, which in turn had more woody species. The study concluded that the indigenous systems of landscape classification provided a valuable basis for assessing rangeland biodiversity. Wang (2004) observed that the proportion of the total biomass as rhizomes increased considerably with increased grazing intensity, and peaked on the extremely high grazing treatment. Shoot and tiller densities, and the proportion of the total biomass as rhizomes were strongly negatively correlated with soil organic matter content and soil moisture.

Brereton *et al.* (2005) considered swards as being structured into two phases: a long phase associated with old dung patches, and a short phase. The members of the herds are assumed to select a feeding station based on preference for leafiness of the encountered state and the phase. The model of herbage utilization adequately described the changes in intake and sward structure during grazing and it was concluded that it was suitable for use as part of a simulation of a grazing system. Chocarro *et al.* (2005) studied

the effects of one severe winter-grazing of lucerne over 3 years in the Ebro Valley, Spain. The traditional practice, i.e. of grazing lucerne with sheep once in the winter season, results in only a limited reduction in yield in the spring. In addition, the spring crop has a higher nutritive value. Hirata *et al.* (2005) evaluated that the higher cover of herbaceous vegetation showed higher grazing impacts which reduced the total available forage at the end of the growing season by the end of the dry season. On the contrary, lighter grazing impact would occur with a higher cover of shrub vegetation types. The importance of maintaining plant cover over the rangeland area to protect the land against soil erosion is stressed. Miller & Thompson (2005) stated that *Cortaderia pilosa* was the predominant species consumed during the cooler periods of the year. In the summer, when the highest live weight gains of sheep occur, the proportion of fine grass species, including *Poa spp.*, *Festuca magellanica* and *Agrostis capillaris*, and herbs and sedges in the diet was highest. Herbage intake was the highest during the summer periods when digestibility was also at its peak. Ross *et al.* (2005) stated that the impact of harvest timing on total yield decreased as the proportion of berseem clover in the intercrops increased. With decreasing density of oats, dry matter yield of first-cut intercrops and total dry matter yield of oats decreased, while regrowth and total dry matter yields of berseem clover increased. Oats–berseem clover intercrops showed potential to manipulate the pattern of annual forage yield and to provide flexibility of harvest without reducing annual yields.

Dalle *et al.* (2006) determined the density and cover of woody species in 192 plots of 500 m^2. Results showed that plant density was 3014 woody plants ha^{-1}. Cover of woody plants was 52%, indicating an increasing trend from ≤40% cover reported in the early 1990s. It was concluded that the increase of woody plants density and cover has crossed the critical threshold and has entered into the encroached condition. Knoop & Smith (2006) recorded changes in the extent of grazing of different grass species, height differences between grazed and ungrazed tillers and intensity of cropping per tuft. In the dry year, the extent of grazing in the upland exceeded that in the bottomland, and several upland grass species little used the previous year became heavily grazed. Milewsk & Madden (2006) examined that intensive browser utilization were observed to lose shoot tips, produce long thorns, and have relatively few flowers and fruits. Browser utilization was associated with increased lateral branching and with an increased occurrence of

short, thickened spines. Pavlu *et al*. (2006) stated that delayed defoliation resulted in an increase in the number of forbs plants, particularly in the number of *Taraxacum* spp. most probably due to an enabling of its seed production. It is evident that increased plant density as a function of intensive defoliation was not restricted to the frequently documented effect on grass tillers but also can occur in many legume and forbs species in species-rich grasslands. Randall & Diaz (2006) experimentally tested plant community responses of spring-fed wetlands to two levels of grazing intensity (light and moderate) and no grazing over 10 years. An herbaceous cover over time was negative under moderate grazing but positive under light grazing and without grazing. Species composition was highly variable from year to year at springs. Smit *et al*. (2006) stated that grazing intensity was significantly higher in plots without unpalatable plants, and significantly higher in plots with *Cirsium* than with *Gentiana*. Large tree saplings survived significantly better than small ones, and depended less on the unpalatable plants for survival. This study shows that unpalatable plants can enhance tree regeneration in wooded pastures.

Loeser *et al*. (2007) concluded that high-impact grazing had strong directional effects leading to a decline in perennial forbs cover and an increase in annual plants, particularly the exotic cheatgrass (*Bromus tectorum*). Cattle removal resulted in little increase in native plant cover and reduced plant species richness relative to the moderate grazing control. Intermediate level of cattle grazing may maintain greater levels of native plant diversity than the alternatives of cattle removal or high-density, short-duration grazing. Peters (2007) stated that the gastropods and small mammals both were important controllers of California annual grassland that exert similar influences on production and composition. Selective consumption of grasses by gastropods and small mammals partially offsets the competitive advantages associated with their early germination.

The following research is available on palatability of range plants in Pakistan.

Neal & Miller (2007) reported some herbaceous species may have been adversely affected by livestock grazing, overall species richness suggests strong ecosystem resilience to grazing, with levels no different after seasonal rains regardless of grazing level. Many grass and herb species absent from open sites during the dry season reappeared after rain, which suggests that livestock grazing may eliminate them as the

dry season proceeds, but that a soil seed or bud bank persists in Khirthar National Park, Pakistan. Akram *et al.* (2009) evaluated that the uncontrolled grazing leads to overgrazed pastures. The Pakistan Council of Research in Water Resources has converted the severe desertified land into productive land as a model on more than 100 ha at Dingarh Cholistan through sand dune fixation and stabilization by mechanical and vegetative means. Although once desertified, the area is now under forest trees, orchard of grafted *Zizyphus* and date palm, fodder crops and grassland grown with collected rainwater and saline groundwater.

E. Rangeland Productivity

Beck & Peek (2004) analyzed that species lists in enclosures and cattle treatments overlapped 48.9 - 68.4%. There was no difference in fall or graminoid herbage between controls and quadrats clipped lightly in early summer and mid-summer and there was no difference in forbs or graminoid yield (seasonally clipped herbage plus end of growing season herbage) in clipped quadrats and controls. Timothy *et al.* (2005) reported that timing and duration of grazing have dramatic influences on cattle distribution in riparian and upland range areas. In general, early in the grazing season, when upland forage is green and growing, cattle tend to distribute more uniformly than later in the season, when upland vegetation is dormant and cattle disproportionately use riparian areas. In addition, early in the season, cattle grazing forested rangelands seem to prefer south-facing aspects with more open canopies when compared with late-season distribution patterns when concentration switches to northerly aspects, denser canopies, and more diverse diets throughout the western United States. Marley *et al.* (2006) stated that dry matter yields (with Oberhaunstaedter having the highest DM yield at cut 3) better in both harvest years compared with other varieties. Chemical analyses showed differences among silages of varieties of *L. corniculatus* and that the ammonia-N concentration of *L. uliginosus* silage was higher than that of *L. corniculatus*. Overall, the variety Oberhaunstaedter was found to be the most suitable variety for silage production. Armstrong *et al.* (2010) examined options for a dairy farm in the high rainfall area of Gippsland (southern Victoria, identified (i) increased herd size without purchasing more land, (ii) increased milking area and (iii) purchasing non-milking area for production of conserved fodder. The purchase of an additional out block for fodder production reduced risk compared with the

base farm system, but did not improve the profitability of the farm system. Other options significantly reduced profit while increasing risk.

The research on the range land productivity from Pakistan is summarized as below.

Jasra & Johnson (2000) reported that biomass production above ground in a given season and quality of major plant species were determined at four growth stages for two consecutive years in grassland of Baluchistan, Pakistan. A relative palatability index of major plant species and preference of sheep and goats was also determined. Forage quality decreased with the advancement of growth stages in all plant forms (grasses, forbs and shrubs). Farooq (2003) reported that rangelands are the largest natural resource, occupying about 62 percent of total area of Pakistan. These rangelands produce and support more than 91.091 million livestock heads. Most importantly, there is a need to improve the production potential of the grasslands of the country by converting them into the sown pastures. Abbasi & Khan (2004) concluded that white clover can easily be grown and established in the hilly areas of Rawalakot, and would sustain a high level of pasture production and provide inputs of N through N_2 fixation which, in turn, would increase the productivity potential of soils in mountain eco-regions. Hussain & Durrani (2007) stated that the months of July and August were the most productive months in Harboi rangeland. The total dry biomass, biomass contributed by grasses, herbs and shrubs generally increased from April through August; and thereafter it progressively decreased till October. It is recommended that a blend of traditional and modern methods of range management with the participation of local communities be tried for its sustainable use. Kiyani (2008) observed that negative but insignificant correlation was found between output per cultivated acre and farm size. The small and large farm sizes have the more land productivities then middle farms. Reasons being that the productivity is high in small farms due to the intensive labor and irrigation use and middle farm used inefficient combinations of inputs while large farm used the maximum capital.

F. Chemical Evaluation of forage Plants

Storeheier *et al.* (2002) stated that wintergreen parts of graminoids had high contents of crude protein (0.072-0.108 g/kg dry matter (DM)) and water-soluble carbohydrates (0.098-0.167 g/kg DM) and were highly digestible (50-65% IVDMD)

compared with the withered parts of the plants (27-53% IVDMD). The digestibility of both shrubs and graminoids was inversely related to cellulose and lignin contents, but positively correlated with increasing contents of water-soluble carbohydrates. Dave & Dave (2003) stated that. P and K levels were typically adequate for beef cattle early in the growing season and declined to deficient levels by July and August. Iron was of no concern, because concentrations were more than adequate for cattle among all the grasses for all seasons. While a mixed stand of forages can extend the period of adequate mineral nutrition for cattle in some instances. Enujiugha (2003) reported that the proximate chemical composition of freshly harvested mature conophor nut (*Tetratcarpidium conophorum*) had 29.09% protein, 6.34% fiber, 48.9% oil, 3.09% ash and 12.58% carbohydrates on a dry weight basis. The elemental concentrations in the raw conophor nut had high phosphorus content (465.95 mg/100g) while cadmium and nickel were very low (0.01 and 0.38 mg/100g, respectively).

Coskun *et al.* (2004) estimated the metabolized energy concentrations of the whole plant, leaves and stems to be 12·2, 11·9 and 12·7 kg $^{-1}$ dry matter (DM), respectively. This compares favorably with high quality forages commonly used in ruminant feeding. The results show that *Prangos ferulacea* may be regarded as high energy forage, but further research is needed on its intake characteristics and the levels of animal performance. Seiler & Campbell (2004) determined the genotypic variability among and within wild Jerusalem artichoke populations for the level of N, P, Ca, Mg, K, and the Ca/P ratio in the forage. The adequacy of Jerusalem artichoke forage at flowering for maintenance of a ruminant animal was classified as follows: N, Ca, Mg, and K as adequate, P inadequate, and the Ca/P ratio as excessive. There were genotypic differences among the nine populations for N, K, P, Ca, Mg, and the Ca/P ratio. Starks *et al.* (2004) determined the feasibility of estimating concentrations of nitrogen (N), neutral detergent fiber (NDF) and acid detergent fiber (ADF) of live, standing forages. It was shown that estimates of N, NDF, and ADF from the radiometer explained from 63 to 76 percent of the variability expressed in the laboratory data, and were equivalent to those estimates derived from the NIRS. Such a remote sensing approach would enable real-time assessment of forage quality, would allow mapping of the nutritional landscape could be

used as a tool to better manage pastures and supplements, and would assist in making harvesting decisions.

Carvalho & Saraiva (2005) reported that water stress period was responsible for a significant increase in sugar, ash, both macro elements (Ca, Na, K, Mg) and microelements (Fe, Zn, Mn, Cu) as well as phytate contents. The results obtained are relevant for selection of better mineral nutritive value of seeds from lupin species. Cherney & Cherney (2005) reported that species selection, fertilization and harvest management can have a major impact on forage K concentration and low K is critical for non-lactating dairy cow forage. Yield of dry matter was 5.6% higher under split applications of K fertilizer compared with the K fertilizer treatments. Forage quality was not greatly impacted by K fertilization although the K concentration of forage increased by 12% due to K fertilization. Smith *et al.* (2005) reported that indehiscent fruits of six tree species, common in Matabeleland were examined *in-vitro* trials. *Acacia nilotica ssp. nilotica* contained more total phenolics than *D. cinerea,* but less nitrogen (N) and fiber (ADF and NDF. However, when fed a supplement of *D. cinerea* untreated or treated with PEG or NaOH, digestibility and N-retention were highest and similar to a commercial goat meal, with the untreated fruit.

Staaland *et al.* (2006) analyzed that several of the most important reindeer forage plants in Svalbard for content of minerals (Na, K, P, Ca, Mg, S, Cl, Fe, Cu, Mn, Zn, Mo and Co) and for content of ash, crude protein, crude fiber, ether extracts and nitrogen free extracts. The Svalbard vegetation had higher contents of Na, Ca, Mg, Cl, Fe and Co, than similar plants from Southern Norway. The contents of other elements examined seemed to be more equal in Norway and on Svalbard. Starks *et al.* (2006) determined the seasonal variation in herbage mass, neutral-detergent fiber (NDF), acid-detergent fiber (ADF) and crude protein (CP) concentrations of herbage and canopy reflectance of pastures of genotypes *Cynodon dactylon* and to analyze the relationships between these descriptors of nutritive value of herbage and canopy reflectance in broad spectral wavebands

Dairo & Adanlawo (2007) reported that the nutritional potentials of two green leafy vegetables namely, *Crassocephalum crepidioides* (CC) and *Senecio biafrae* (SB) were evaluated through their proximate composition, mineral and amino acid profile. *Crassocephalum crepidiodies* contained 27.17±0.51% crude protein (CP) while that of

Senecio biafrae was 28.93±0.68% but were not significantly different. The crude fiber contents for SB was 7.26±0.22% while that of CC was 8.13±0.06%. The ash content for SB was 16.30±0.21% and 17.31±0.02% for CC. The nitrogen free extract (NFE) for SB was 20.81±1.36% while CC recorded a value of 19.03±0.56%. The study indicates that *Crassocephalum crepidioides* and *Senecio biafrae* are good sources of protein in the nutrition of both human and animal. Garg *et al.* (2007) worked on mineral composition of 15 wild herbs. Several herbs were enriched in Ca, Co, Cu, Mg, P, Fe, Mn and Zn. Often used as antibacterial, antipyretic and heart tonic is specially enriched in Co, Cr, Cu, Na, Mn, Fe, Rb and Zn. These were also used as fodder forage. An attempt has been made to correlate elemental contents with the therapeutic importance of various herbs. Phillips *et al.* (2007) reported that performance of calves grazing warm-season grass pastures is usually reduced during the last half of the summer as compared to the first half, because as the plant mature the concentration of protein in the plants falls below the dietary nutrient requirement needed to maintain animal growth. Providing supplemental protein to calves during the last half of the summer grazing season can increase animal performance, but knowing when to begin supplementation is difficult.

Alshammary (2008) concluded that Na ion uptake by plant roots was significantly less than K in *A. halimus* compared to *S. persica* which indicated adjustment of plants to high soil salinity and high Na ion concentration for better growth. The order of increasing salt tolerance was *A. halimus* > *S. persica* under the existing plant growing conditions. Among the two halophytes, *A. halimus* showed great potential for establishing gene banks of local species, because it has more forage value due to high protein contents than *S. persica* for range animals. Chiesa *et al.* (2008) reported that organic matter, neutral-detergent fiber and nitrogen intake, as well as rumen ammonia-N concentration, decreased linearly with age of regrowth. Acid-detergent fiber and indigestible intakes were similar for all treatments. Apparent digestibility of organic matter NDF and N, as well as true digestibility of OM, microbial protein synthesis in the rumen, N retention, pH of rumen fluid and sugars, amino acids and peptide concentrations in rumen fluid were similar for all treatments. Gutierrez *et al.* (2008) investigated the chemical composition of 14 weed species in Mexico. The mineral, crude protein, fiber, and total phenolic contents were analyzed. The crude fiber and protein contents in most of the weeds fell into the

recommended range for the maintenance of cattle. The phenolic contents of weed extracts were higher than that reported for several Mediterranean forage species. Leheska *et al.* (2008) determined the percentages of total fat, total cholesterol, and fatty acids along with *trans* fatty acids and CLA for grass-fed and control SS and GB. Grass-fed SS had less total fat than control SS, but both grass-fed and control SS were considered lean, because their total fat content was 4.3 % or less. For both GB and SS, grass-fed beef had significantly less. Although the fatty acid composition of grass-fed and conventionally fed beef was different. Zhao *et al.* (2008) reported that forage nitrogen (N) and nonstructural carbohydrate (NSC) concentrations are important indicators of forage quality, and knowledge of N and NSC variation among grass germplasm is one element to consider in developing a successful forage and livestock management program. The concentrations of N, neutral detergent fiber (NDF), acid detergent fiber (ADF), glucose, fructose, sucrose, fructans, and starch in 13 perennial cool-season grass entries from five plant species.

The review on chemical evaluation of forage plants in Pakistan are summarized as follows.

Sabir *et al.* (2003) compared the chemical composition and of vegetables, pulses and those of *Lentinus edodes*, the cultivated *shiitake* mushroom. Chemical constituents included total dietary fiber, crude protein, fat, ash, moisture and carbohydrate. Despite the differences in the chemical composition of mushroom samples, the overall nutritional values of the mushrooms were good.

Khan *et al.* (2005) found that sampling period affected soil Cu^{2+}, Zn^{2+}, Se^{2+} while all forage minerals except Se^{2+} were affected by sampling times. Forages contained marginal deficient level of Co^{2+} during winter, those of Co^{2+} and Se^{2+} during the summer. Moderate deficient levels of Fe^{2+} and severe deficient level of Zn^{2+}, Mn^{2+} and Co^{2+} were found during the summer. Forage Co^{2+}, Fe^{2+}, Zn^{2+}, Mn2+ and Se^{2+} during winter were found to be adequate for the requirement of ruminants.

Khan *et al.* (2006a) reported that seasonal changes were found in all soil micro-minerals except zinc, while forage iron, zinc, and selenium were affected by seasonal changes. All soil mineral levels except cobalt and selenium were sufficiently high to meet the requirements of plants for normal growth during both seasons. Soil Fe, Zn, Co, and

Se levels were higher, and Cu and Mn lower during winter than those during summer. Forage Zn levels during summer were at marginal deficient levels, and in contrast, all other forage micro-minerals was within the required range for ruminants during both seasons. Although forage micominerals were within the range required by the ruminants. Khan *et al*. (2006b) measured the levels of macro and micro minerals of herbage forages of a grazing pasture of Leiah District of South-Western Punjab, Pakistan. The grazed forages had different concentrations of Ca and Mg, respectively, and were slightly higher than the minimum recommended levels in the diets of ruminants. Content of micro minerals varied among the grazing pasture forages. The forages had lower levels of Cu and slightly low to moderate contents of Zn as compared to recommended dietary requirements of ruminants. Kiyani *et al*. (2007) determined alkaloids, saponins, tannins and quantification of total phenolic contents in plants of Hazarganji Chiltan National Park Quetta. *Caragana ambigua, Clematis graveolens, Juniperus excelsa* and *Pistacia khinjak* contained all three secondary metabolites while *Chrysopogon aucheri, Ferula oopoda, Fraxinus xanthoxyloides, Pennisetum orientale, Saccharum griffithii* and *Verbascum erianthum* lack these three secondary metabolites. Sultan *et al*. (2007) identified that the mean *in-vitro* dry matter digestibility (IVDMD) and metabolizable energy (ME) of marginal land grasses at early bloom stage were 58.4±2.05% and 7.74±0.29 MJ/kg DM, respectively, whereas, mean IVDMD and ME at mature stage were 43.3±1.89% and 5.64±0.25 MJ/kg DM, respectively. The chemical and structural composition, IVDMD, RP and PIR values indicate that marginal land grasses be fed to livestock with some supplementation for different levels of production and types of livestock. Khan *et al*. (2007) studied the levels of Ca, Na, Cu, and Zn in forage plants Punjab, Pakistan. They found that minerals were significantly increased, generally with plant maturity from summer to winter. Grazing ruminants in the pastures might possibly be deficient in most minerals and these grazing pastures are not providing adequate levels of the minerals to the livestock grazing therein. Supplementation is the urgent need for grazing livestock to prevent deficiency diseases due to mineral imbalances

Hussain & Durrani (2008) analyzed the mineral composition including K, P, Cu, Mn, Fe and Zn of some grasses and shrubs analysed at three phenological stages from Harboi rangeland, Kalat, Baluchistan. There were non-significant differences between

grasses and shrubs in K, P, Fe and Zn contents. The concentration of Cu was higher in shrubs than grasses while Mn was higher in grasses than shrubs. The differences in the K, P, Mn, Fe and Zn were insignificant among the various phenological stages. Generally K and Fe were sufficient while P and Zn were deficient in most of the analysed forage plants. Rehman & Iqbal (2008) stated that high concentration of ferric and lead was observed in the foliage of *A. indicum* which were collected from Tanveer Garment factory as compared to foliage collected from a control area of Karachi University Campus. The level of copper and chromium was highest in the foliage of *S. holosericea* at Khan Towel factory than control site. Khan Towel factory also caused considerably high amount of lead in the foliage of *P. juliflora* as related to control site. The research demonstrated that accumulation of different metals was generally higher in the foliage of naturally growing plants collected from the industrial areas Korangi and Landhi Karachi. Rahim *et al*. (2008) analyzed the nutritive value of twelve marginal land grasses of Himalayan Pakistan. The mean *in vitro* dry matter digestibility (IVDMD) and metabolizable energy (ME) of marginal land grasses at early bloom stage were 58.4±2.05% and 7.74±0.29 MJ/kg DM, respectively, whereas, at mature stage were 43.3±1.89% and 5.64±0.25 MJ/kg DM, respectively. It is suggested that the macro and micro mineral composition, IVDMD, RP and PIR values of marginal land grasses are suitable for feeding to livestock with some supplementation for different levels of production and classes of livestock. Ahmad *et al*. (2008b) reported different plant parts such as leaves, leaflets and pods, which were lavishly grazed by the grazing animals in Soone Valley, Punjab, Pakistan, were separated and analyzed for macro-minerals, Na, P, K, Ca and Mg. It was concluded that most of the forage samples were sufficient in Na, P, K, Ca and Mg for the requirements of ruminants grazing therein. Comparatively, the macro-mineral concentrations in pods were higher than those found in the leaves and leaflets showing no need of mineral supplementation.

Abbasi *et al*. (2009) compared legumes and grasses and stated that white clover forage had high nutritional value and quality. Plant nutrient content of N, P, K, Ca, Mg, Fe, Mn, Cu and Zn were determined in the forage. Mineral nutrient contents in white clover were substantially higher than those found in the grass. Among macronutrients, the content of P and K were 0.32 and 1.96%, while the contents of N, Ca and Mg were 2.61,

1.10 and 0.29%, 2–3 fold to the content found in the grass. Micronutrients also showed similar trend and the concentration.

Cheema *et al*. (2010) reported that dry matter (TDM), crop growth rate (CGR), leaf area duration (LAD), seed yield, oil yield and protein content were significantly affected by different nitrogen rates. The highest N level (120 kg ha-1) produced maximum values for all these traits as compared to minimum in control during both years of study. Time of nitrogen application did not significantly affect TDM, CGR, protein and oil contents however, split application of nitrogen (½ at sowing + ½ at branching or flowering) produced significantly higher seed and oil yield than full nitrogen at sowing or its split application as ½ at branching + ½ at flowering.

No work can be traced from on the nutritional and mineral composition of forage plants of District Tank. This gap of knowledge is being filled during this study.

G. Conservation Status of Plants

Maria *et al*. (2005) stated that with more than 56,000 species (excluding fungi) Brazil has one of the richest flora in the world which is nearly 19% of the world flora. Knowledge of angiosperms, especially monocotyledons (of which 45% of the species are endemic), is more reliable than any other flora. Prakash (2005) found 60 threatened medicinal plant species of which 54 species occurred in the sampling plots. Twenty-two percent of threatened medicinal plant species were critically endangered, 16% were endangered, and 27% were vulnerable. Thirty-two threatened medicinal plant species were endemic to the Himalayan region.

Raimondo *et al*. (2007) updated the red list for South Africa's plant species. It also focuses on almost 70% of threatened plant taxa that occur in the Fynbos Biome by providing the latest statistics on how many of the Fynbos plants are threatened, what the predominant threats are affecting Fynbos species, which new threats have appeared in the past decade. Ture & Bocuk (2007) reported that *Bromus* 10 sp., *Poa* 9, *Aegilops* 8, *Phleum*, *Stipa* and *Hordeum* 6 each, *Avena* 5, *Elymus*, *Eremopyrum* & *Lolium*, *Alopecurus*, *Melica* and *Secale* 3 each were found in Eskişehır Province Turkey. The phytogeographic elements was Euro-Siberian 20 (16.0%), Irano-Turanian 12 (9.6%), Mediterranean 6 (4.8%) and East Mediterranean 3 (2.4%). When the risk categories of the plant taxa are considered, it can be seen that 1 taxon is in VU (*Vulnerable*), 1 taxa in

DD (*Data Deficient*) and 3 in LC (*Least Concern*) categories. Four (3.2%) species were endemic.

Fischer & Bliss (2008) examined owners' knowledge, beliefs, values, and socioeconomic contexts through in-depth individual and focus-group interviews to understand their motivations to conserve oak. Owners had complex motivations for conserving oak. Policies that use symbolism to inspire behavior and policies that build capacity can harness owners' stewardship ethics and moral obligations.

Kimmel *et al.* (2009) reviewed the diversity and status of wetlands in Estonia and describe the main problems and challenges of sustainable wetland use. The main challenges of wetland preservation and use are: (1) management of drained wetland areas that have become sources of greenhouse gases; (2) attaining the sustainable use of peat resources and ensuring the restoration of cut-away peat lands; (3) maintenance of the traditional management of valuable semi-natural wetlands. Tandon *et al.* (2009) stated that in Northeast India region the valuable plant genetic resources are being lost at an alarming rate due to varied human activities including shifting cultivation and fuel wood which have in turn led to the depletion of forest cover. Therefore, there is an urgent need for conservation, sustainable utilization and management of plant genetic resources of the region so as to meet the growing requirements of food, fodder, fiber, health, water and other needs.

Bulut & Yilmaz (2010) reported that of the 3504 endemic plants in Turkey, 12 are known to have been extinct and 3492 (99 %) are still being threatened. Of 61 endemic plants in Kemaliye region, 5 is known to have been extinct and 54 (88%) to be threatened. This study provides some suggestions about conservation and management of such plants by considering their threatened categories. Dansi *et al.* (2010) observed that two plants species *Digitaria horizontalis* and *Digitaria longiflora* were reported by farmers as putative parents of cultivated fonio. Of these, only *Digitaria longiflora* has interesting agronomic traits (erect habit; stem long, big, strong and resistant to lodging; panicle long and rich in grains; large sized seeds) that are useful for the improvement of cultivated fonio. In the entire study area, the crop is under threat. Therefore, concerted efforts should be deployed to preserve its diversity and increase its use to combat food insecurity and malnutrition in Benin. Zhang & Wenming (2010) investigated the

protection of *Taxus chinensis* var. *mairei* medicinal plant species, the biological and ecological characteristics of its populations were investigated and analyzed in Shanxi. The study area, southeastern Shanxi, is a special region suitable for this species growth and development. The floristic composition, life form spectrum, and species diversity of *Taxus chinensis var. mairei* forests reflected the features of both warm-temperate and subtropical regions.

Literature on the conservation of flora of Pakistan is reviewed as follow:

Ahmad *et al.* (2007) conducted a survey of *in-situ* conservation in mountainous region of Pakistan on ten stuffy sites in the valley, selected on the basis of variation in their ecological parameters. Results showed that most observed plant species in this specific valley may be due to some morphological and anatomical as well as physiological adaptations to this environment which is mainly responsible for their survival and perpetuation in this harsh habitat. Alam & Ali (2010) reported that *Androsace russellii* is exclusively endemic in District Gilgit, Pakistan. It was originally reported from Gharesa glacier, Gilgit district. A current six-year re-assessment (i.e., 2003-2008) revealed that this species has now restricted in two localities of Hunza (Gilgit) i.e. Ultar Nullah and Shatu Bar despite of previously mentioned locality. Eleven field surveys were made from 2003 to 2008 in connection with the study of its distribution, nature of habitat, population size and mode of reproduction in the natural habitat.

Abbas *et al.* (2010) worked out the conservation status of *Cadaba heterotricha* in Pakistan. Based on four years extensive field studies including population size, geographic range and habitat, *Cadaba heterotricha* are classified as endangered (EN) species in Pakistan.

There is very little work available on the conservation of plants of Khyber Pakhtunkhwa as follows.

Hadi *et al.* (2009) reported that the Muslim graveyard of Palosi, District Peshawar are excellent conservatories of plant natural resources because the people hesitate of cutting plants, grazing animals in graveyards. *Aerva javanica*, *Capparis decidua*, *Prosopis farcta* and *Peganum harmala* were common in graveyard and were almost absent in the surrounding areas.

Hussain *et al*. (2010b) reported 135 endangered plants from Karachi. Of which 8 species is already extinct including *Tecomella undulata*, ten species as endangered, 25 rare species and 28 vulnerable species.

In the present study an effort is made to record the present conservation status of the plants of the area.

Aims and Objectives

The review of literature on various aspects of floristic, vegetation, ethnobotany, chemical analysis and conservation status indicated that no such work has been done on the plants of District Tank. The aims of the present study were therefore to:

1. To prepare floristic list with their ecological characteristics.
2. To classify plants ethnobotanically.
3. To workout the vegetation structure and its characteristics.
4. To evaluate the interaction between the local community and the plants in relation to:
    a. Fuel wood utilization
    b. Forage plants
    c. Medicinal plants
    d. Timber wood plants
    e. Any others
5. To see the palatability and availability of fodder plants in relation to animal use.
6. To assess the rangeland productivity.
7. To evaluate some key palatable plants chemically for mineral and nutrition status at different phenological stages.
8. To assess the role of gender in utilization and conservation of resources.
9. To know the conservation status of plants.

MATERIALS AND METHODS

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1. Floristic Structure and Ecological Characteristics

Floristic survey was conducted throughout District Tank during 2007- 2009 in various seasons. Plants from various localities were collected, preserved and identified with the help of Flora of Pakistan (Nasir & Ali, 1971-1995, Ali & Qaisar, 1995-2010). The identification was later on confirmed at Herbarium, National Agriculture Research Council, Islamabad, Herbarium, Pakistan Museum of Natural History, Islamabad and Herbarium, Department of Botany, University of Karachi. A complete floristic list was alphabetically compiled. The voucher specimens were numbered and deposited in Herbarium, Department of Botany University of Peshawar.

1.1 Biological Spectra

Plants were classified into various Life-form classes following Raunkiaer (1934) and Hussain (1989) as follows:

i. Therophytes (Th)

These are the annual seed bearing plants which complete their life cycle in one year and over winter the unfavorable seasons by means of seeds and spores.

ii. Geophytes (G)

Their perennating buds are located below the surface of soil and include plants with deep rhizomes, bulbs, corms, tubers and may also include hydrophytes which may be submerged, partly submerged, free-floating and leaf-floating.

iii. Hemicryptophytes (H)

These are the herbaceous perennials in which aerial portions of the plants die at the end of growing seasons leaving a perennating bud at or just below the ground surface may be covered by litter

iv. Chamaephytes (Ch)

Their perennating buds are located close to the ground surface below the height of 25cm.

v. Phanerophytes

a. Nanophanerophytes (NP)

Their perennating buds are borne on aerial shoots from 0.25 m (25 cm) up to 2 m (0.8 ft to 6 ft) above the ground surface.

b. Microphanerophytes (MicP)

These are shrubby plant species with perennating buds located above 2 m to 7.5 m (6 ft to 25 ft) height.

c. Mesophanerophytes (MesP)

These are small trees with their perennating buds are located from 7.5 m to 30 m (25 ft to 100 ft) height.

d. Megaphanerophytes (MgP)

These are tall tree species whose perennating buds are located above the height of 30 m (100 ft).

Raunkiaerian and quantitative spectra were calculated as fallows.

a. Raunkiarean Life form spectrum = $\frac{\text{No. of sp. falling in a particular life form class}}{\text{Total number of all the species}} \times 100$

b. Quantitative life form spectra were calculated on the basis of importance value of each species encountered in sampling by quadrat by following Cain & Castro (1956) and Qadir & Shetvy (1986).

1.2. Leaf Size Spectra

Plants were classified into various Raunkiaerian (Raunkiaer, 1934) and quantitative leaf sizes as follows:

i. Leptophyll (L).	Leaf area up to 25 mm^2
ii. Nanophyll (N).	Leaf area from 25 to 225 mm^2
iii. Microphyll (Mic).	Leaf area from 225 to 2025 mm^2
iv. Mesophyll (Mes).	Leaf area from 2025 to 18225 mm^2
v. Macrophyll (Mac).	Leaf area from 18225 to 164025 mm^2
vi. Megaphyll (Meg).	Leaf area larger than class v.

a. Raunkiaerian spectrum was calculated as follows:

Leaf size spectrum = $\frac{\text{Number of species falling in a particular leaf-size class}}{\text{Total number of all species for that community}} \times 100$

b. Quantitative leaf size spectra were calculated using importance value indices of plant species following Cain & Castro (1956).

1.3. Phenological behavior

Plants were classified into following four phenological classes as follows:

i. S1. Pre-reproductive-vegetative/seedling stage.

ii. S2. Reproductive stage /Flowering stage.

iii. S3. Reproductive stage Flower plus fruiting stage.

iv. S4. Post reproductive stage /Darmant stage / Drying stage.

1.4. Ethnobotanical Profile

Plants were classified into various categories of uses in the area. The information was gathered from local knowledgeable elderly person and also supplemented with personal observation during the field surveys.

2. Phytosociology/Vegetation Structure

Phytosociological studies were conducted in 6 representative selected sites. These sites were selected on the basis of species composition, habitats, and physiognomic contrast. Vegetation was analyzed by using 5, 10 x 10 m quadrates for trees, 10, 5 x 5 m quadrats for shrubs and 15, 1x1 m quadrats for herbs in each site for four seasons viz. autumn, winter, spring and summer. Density, cover and frequency of each species were measured and values were changed to relative values. The plant communities were established based on highest importance values.

2.1 Density

Density is the average number of individuals of a species in unit / area

$$\text{Density} = \frac{\text{No. of individuals of a species}}{\text{Total No. of Quadrats}}$$

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Total densities of all species}} \times 100$$

Ten density classes were established as follows; and the mid points were used for calculations:

Class	Range (No of individuals)	Mid point value
1.	Up to 10	5
2.	11 – 20	15
3.	21 – 30	25
4.	31- 40	35

5.	41 – 50	45
6.	51 – 60	55
7.	61 – 70	65
8.	71 – 80	75
9.	81- 90	85
10.	91 – 100	95

2.2 Herbage Cover

Cover is the vertical projection of foliage shoots/crown of a species to the ground surface expressed as fraction or percent of a surface area.

$$\text{Cover} = \% \frac{\text{Cover of a species}}{\text{Total cover of all species}}$$

$$\text{Relative Cover} = \frac{\text{Cover of a species}}{\text{Total Cover of all species}} \times 100$$

Following ten cover classes were established for estimating plant cover. Mid point values were used for calculation.

Class	Range (No of individuals)	Mid point value
1.	Up to 10	5
2.	11 – 20	15
3.	21 – 30	25
4.	31- 40	35
5.	41 – 50	45
6.	51 – 60	55
7.	61 – 70	65
8.	71 – 80	75
9.	81- 90	85
10.	91 – 100	95

2.3 Frequency

Frequency is the percentage occurrence of species in an area.

Frequency was determined as follows.

$$\text{Frequency} = \frac{\text{No. of quadrats in which a species was present}}{\text{Total number of quadrats applied}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}} \times 100$$

2.4. a. Importance Value

The relative values of each parameter for species were added to get the importance values. The community was named after the three leading species having the highest importance values as follows.

$$IV = RD+RC+RF$$

2.4. b. Family Importance Value

Importance value of each species in a particular families was added together to give rise FIV for all the quantitatively recorded families.

2.5 Determination of Similarity Index

Similarity index was calculated by using Sorensen's index (Sorensen, 1948) as modified by Motyka *et al.* (1950), which used quantitative value rather than simply computing presence or absence of species. The similarities among the stands were compared.

$$IS_{MO} = \frac{2W}{A+B} \times 100$$

Where: W = Sum of lowest quantitative value of the species pair common to both communities,

A = Sum of quantitative value of all species in community A,

B = Sum of quantitative value of all species in community B.

Index of dissimilarity was calculated as, ID = 100 - Index of Similarity

2.6 Determination of Homogeneity

The homogeneity or uniformity of the community was calculated by using Raunkiaer's Law of Frequency (Raunkiaer, 1934) as follows.

$$A > B > C \geq D < E.$$

A = Present in up to 1-20%,

B = Present in up to 21-40%,

C = Present in up to 41-60%,

D = Present in up to 61-80% and

E = Present in up to 81-100%.

2.7 Species Diversity

Species diversity was calculated by Simpson's index of diversity (Simpson, 1949).

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

Where: D = Diversity index,

N = Total number of individuals of all species,

n = Number of individuals of a species.

2.8 Species Richness

Species richness was calculated by using following formula (Menhinick, 1964).

$$d = S/\sqrt{N}$$

Where: S = Total number of species in a stand

N = Total number of individuals in a stand and

d = species richness

2.9 Maturity Index

The community maturity index was obtained by Pichi-Sermolli (1948) method.

$$\text{Degree of maturity index} = \frac{\text{Frequency values of all species in a stand}}{\text{Total number of species in a stand}}$$

2.10 Cluster Analysis

Cluster analysis (CA) is a classification technique for placing similar objects into group or clusters. The arrangement is a hierarchical tree like structure is called a dendrogram. These clusters or groups of sampling units may represent different biotic communities. The community classification was performed following programme

Multivariate Statistical Package (MVSP). The classification was based on compositional dissimilarity among stands and dendrograms were constructed for vegetational stands of the area.

2.11 Principal Coordinate Ordination

Principal coordinate analysis is the most widely used ordination procedure in ecology and available in computer statistical packages (MVSP). It is basically a multivariate statistical technique that deals with the internal structure of matrices. Principal coordination analysis is a method of breaking down or partitioning a resemblance matrix into a set of orthogonal (perpendicular) axes or components. The ordination provides information about the ecological resemblance between communities. Cluster analysis and DCA was applied to dissimilarity data of 24 stands.

3. Edaphology

Soil samples were collected during July and August, 2007-2009, from 0-15 cm depth at six different sites and analyzed for elemental composition and physico-chemical characteristics.

3.1 Soil Texture

A soil texture was determined by Hydrometer method (Bouyoucos, 1936) and textural classes were determined with the help of textural triangle (Brady, 1990).

3.2 Water Holding Capacity

Water holding capacity of soils was determined by following Hussain (1989).

$$\text{Water holding capacity} = \frac{\text{Wet weight - Dry weight}}{\text{Dry weight}} \times 100$$

3.3 Organic matter

Soil organic matter was determined by oxidation with potassium dichromate in sulphuric acid medium under standard wet combustion method of Rayan *et al*. (1997).

3.4 Calcium carbonate

Calcium carbonate was determined by acid neutralization method (Rayan *et al*., 1997).

3.5 Nitrogen

Total Nitrogen was determined by the Kjeldahl method of Bremner & Mulvaney (1982).

3.6 Phosphorus

Phosphorus was determined after Olsen & Sommers (1982).

3.7 Potassium

Potassium was determined by flame emission spectroscopy (Rhoades, 1982).

3. 8 pH

Soil pH was measured in 1:5 soil water suspensions with a pH meter (Jackson, 1962).

3. 9 Electrical Conductivity

Electrical conductivity of the soil was determined in 1: 5 siol water suspensions with EC meter.

3.10 Total Soluble Salts

TSS was determined by the recommended method of AOAC (1984).

3.11 Carbonates and Bicarbonates

Dissolved carbonates (CO_3^{--}) and bicarbonates (HCO_3^{-}) were determined by titration method (Jackson, 1962) as follows:

$$\text{Carbonates (Meq/liter)} = \frac{\text{Volume of acid used in solution A for } CO_3^{--} \times 2 \times N \times 1000}{\text{Volume of Soil extract}}$$

$$\text{Bicarbonates (Meq/liter)} = \frac{\text{Vol. of acid used in sol. B . Vol. used in sol. A} \times N \times 1000}{\text{Volume of Soil extract}}$$

3.12 Chloride

Dissolved chlorides (Cl) were determined by titrating the soil solution extract with Silver nitrate using Potassium chromate as an indicator (Richard, 1954).

$$\text{Chlorides (Meq/liter)} = \frac{\text{ml. of } AgNO_3 \text{ for sample - } AgNO_3 \text{ for blank} \times 0.005 \times 1000}{5\text{(i.e. ml of water)}}$$

3.13 Calcium + Magnesium

Calcium + Magnesium (Ca^{++}+ Mg^{++}) of soil saturated extract were determined by titration with Ethylenediamine tetra acetate (EDTA) and disodium salt (Versenate) after Richard (1954).

3.14 Sodium

Sodium (Na) content of soil saturated extract was determined by flame photometer.

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3.15 Sodium Adsorption Ratio (SAR)

Sodium adsorption ratio (SAR) was determined after Richards (1954) as follows:

$$SAR = Na^{+} / \sqrt{Ca^{++} + Mg^{++}/2}$$

3.16 Sulphates

Sulphate (SO_4) was determined by precipitation as Barium sulphate (Richards, 1954).

$$SO_4 \text{ (Meq/liter)} = \frac{\text{mg of } BaSO_4 \text{ precipitate x } 8.568}{\text{Volume of Soil extract}}$$

4. Palatability of Vegetation

The degree of palatability of plant species was recorded by observing the grazing livestock in the field. Cattle, goats and sheep were visually observed to determine their preferences. Information was also gathered from local herders. Plants were classified into palatable and non-palatable species following Hussain & Durani (2009a). Palatable plant species were further classified by animal preference; part used and season of availability. Palatable plant species were classified as follows following Hussain & Durani (2009a).

i. Non Palatable (NP): Not grazed by livestock.

ii. Highly Palatable (HP): Plant species that were highly preferred by the livestock.

iii. Mostly Palatable (MP): Plant species with average likeness by the livestock.

iv. Less Palatable (LP): Plant species with less preference by livestock.

v. Rarely Palatable (RP): Plant species rarely grazed under compulsion when no other choice was available.

5. Measurement of Rangeland Productivity

Productivity was measured by harvest method. Since the methods were different for herbaceous and shrubby plant species, therefore, following methods were used for each group.

5.1 Herbaceous Biomass

Above ground herbaceous foliage of grasses and herbs was harvested by species at ground level using 1x1m quadrats. The harvested fresh material was weighed in the field using a field balance (Hussain & Durrani, 2007; Bonham, 1989; Kirmse & Norton, 1985).

5.2 Shrub Biomass

Shrub biomass was estimated by Reference Unit Method (Andrew *et al.* 1981). A representative part of the plant was cut down and weighed. The total parts of the plant was counted and multiplied by the weight of the clipped unit to estimate shrub biomass.

6. Chemical Evaluation of some selected Rangeland Plants

Eleven plant species of different habits (Table 2) were collected at three phenological stages (Pre-reproductive/seedling stage, Reproductive/flowering stage and Post-reproductive /drying stage). The plant selection was based on the animal preferences and availability. Plant samples were dried, powdered and stored in plastic bags for following analysis:

Table 2. Plants selected for chemical evaluation sharing different degrees of palatability.

S. No.	Plant species	Phenological stages		
		Pre-reproductive	Reproductive	Post-reproductive
		Palatability status		
A. Herbs				
1.	*Convolvulus arvensis* L.	HP	LP	HP
2.	*Avena sativa* L.	HP	HP	HP
3.	*Tribulus terrestris* L.	HP	RP	HP
4.	*Trifolium alexandrianum* L.	HP	MP	HP
B. Woody species				
5.	*Zizyphus mauratiana* Lam.	HP	LP	MP
6.	*Acacia nilotica* ssp. *nilotica* (L.) Wild. ex Delile	HP	LP	HP
7.	*Prosopis cineraria* (L.) Druce	NP	HP	LP
8.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	LP	MP	HP
9.	*Salsola foetida* Del.ex Spreng	RP	LP	MP
10.	*Calotropis procera ssp. hamiltonii* (Wight) Ali	LP	NP	MP
11.	*Withania coagulans* (Stocks) Dunal	NP	NP	NP

6.1 Mineral composition

The samples were dried at 70 ^{0}C in a forced air oven for 48 hour AOAC (1990). Dry sampales were ground to pass through 1mm sieve and then subjected to wet acid digestion according to AOAC (1990). The digested plant materials were analyzed in duplicate for mineral composition using Atomic Absorption Spectrometer (GBC, 908AA.Victoria Australia) for Ca, Mg, Fe, Mn, Zn, Cu, etc. Flame photometer (corning flame photometer 410) was used for potassium and sodium and UV/ visible Spectro

Photometer (Shimadzu UV-1601PC) for phosphorus. The total nitrogen was analyzed by Semi-micro Kjeldal apparatus.

i. Statistical Analysis

For comparison of chemical contents of herbaceous and woody plants t-test was applied and a randomized block design was used for comparison of the chemical contents among phenological stages of woody plants and herbs.

6.2 Proximate Analysis

i. Dry Matter

Dry matter (DM) was obtained by oven drying the plant sample at 65 °C for 72 hours by AOAC (1984) method and percent dry matter was calculated as follows:

$$\text{Percent Dry Matter} = \frac{\text{Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

ii. Ash Contents

One to two grams of plant sample was ignited in the muffle furnace at 550 °C - 600 °C for 8 hrs and ash contents of samples were determined by AOAC (1984) method. Percent ash contents were calculated as follows:

$$\text{Percent Ash Content \%} = \frac{\text{Weight of ash}}{\text{Weight of fresh Sample}} \times 100$$

iii. Organic Matter

Organic matter (OM) was calculated as follows:

$$\text{Percent Organic Matter} = 100 - \% \text{ Ash}$$

iv. Plant Digestion

All nutrients determinations involved wet digestion of plant samples. One gm plant material was digested in concentrated selenium sulphuric acid and hydrogen peroxide was added to each digestion tube. The sample was digested by placing digestion tubes on heating blocks. The digestion was continued at 350°C until color of the solution was clear. The prepared solution was diluted with double distilled water and stored in tubes. This solution was used for the analysis of nitrogen /crude protein, potassium, phosphorus, copper, zinc, and manganese using following methods.

v. Nitrogen / Crude Protein

Nitrogen was determined by micro Kjeldahl procedures (AOAC, 1984). Nitrogen in the digested sample was collected in 4% boric acid solution by distillation. Boric acid was titrated against 0.02 normal standardized H_2SO_4 by a semi automatic titrator. Crude protein in the sample was calculated as follows:

$$\text{Percent Crude Protein} = \frac{(\text{ml } H_2SO_4 - \text{blank}) \times N \times 6.25 \times 14.01}{\text{Sample weight} \times 1000}$$

vi. Crude Fiber

Crude fiber (CF) was determined by following AOAC (1984). The sample was digested with 1.25% H_2SO_4 for 30 minutes followed by 30 minutes with 1.25% NaOH. The insoluble residues were dried, weighed, ashed and the insoluble organic matter was reported as crude fiber as follows:

$$\text{Percent Crude Fiber} = \frac{\text{Loss in weight in ignition}}{\text{Weight of Sample}} \times 100$$

vii. Ether Extract (Crude Fat)

Ether extract (EE) procedure involves a reflux apparatus which boils ether, condenses it and allows it to pass through the sample. Ether extract was calculated as follows (Galyean, 1985):

$$\text{Percent Ether Extract} = \frac{\text{Weight of extract}}{\text{Weight of sample}} \times 100$$

viii. Nitrogen Free Extract

Nitrogen free extract (NFE) was calculated after Galyean (1985).

NFE = Dry matter (% Ash + % Crude fiber + % Ether extract + % Crude protein). Nitrogen free extract represent highly digestible carbohydrates.

ix. Gross Energy

Gross energy (GE) of samples was calculated from the proximate composition by following method of Gorrett & Johnson (1983). It was done by multiplying the percentage of each proximate component with its appropriate energy value followed by summation of these products.

$$GE\ (Kcal/g) = 5.72\ (CP) + 9.5\ (EE) + 4.79\ (CF) + 4.03\ (NFE).$$

x. Total Digestible Nutrients

Total digestible nutrients (TDN) for livestock were calculated after Harris *et al.* (1967). Total digestible nutrients are a measure of the digestible energy content of sample on carbohydrate equivalent basis.

Percent TDN % = 37.937 – 1.018 (CF) – 4.886 (EE) + 0.173 (NFE) + 1.042 (CP) + 15 $(CF)^2$ – 0.058 $(EE)^2$ + 0.008 (CF) NFE + 0.119 (EE) NFE + 0.038 (EE) CP + 0.003 $(EE)^2$ CP.

OR:

$$\%TDN = \frac{DE\ (Mcal/Kg)}{0.04409}$$

xi. Digestible Energy

Digestible energy (DE) was calculated from TDN% for sheep and goats following (Anonymous, 1982) as follows:

DE (Mcal/Kg) = TDN% x 0.04409.

OR

DE = 0.0229 (CP) + 0.0349 (EE) + 0.0091 (CF) + 0.00017 $(NFE)^2$ + 0.5 NFE% - 0.068.

xii. Metabolizable Energy

Metabolizable energy (ME) was calculated from digestible energy for livestock Moe & Tyrrell (1976) as follows:

ME (Mcal/Kg) = 0.45 + 1.01 (DE).

xiii. Total Carbohydrates

Total carbohydrates were calculated after Galyean (1985) as follows:

Total Carbohydrates = 100 - % Moisture – (% Ash + % Crude Protein + % Ether Extract

6.3 Cell Wall Constituents

i. Neutral Detergent Fiber

One gm of plant sample was placed in a beaker for refluxing. To it 100 ml of a cold neutral detergent solution and 2 ml of decalin was added. The solution was then boiled for 5-10 minutes and refluxed for 60 minutes. Then it was filtered through a

previously tarred, sintered glass crucible using low vacuum. The filtered mat was broken up and washed twice with hot water. It was further washed with acetone and crucible was dried at 100°C for eight hours and weighed (Van Soest, 1963; Goering & Van Soest, 1970). NDF was calculated as follows:

$$\text{Percent NDF} = \frac{\text{Weight of treatment}}{\text{Sample weight}} \times 100$$

ii. Acid Detergent Fiber

One gm sample was taken into a beaker for refluxing. 100 ml cold acid detergent solution and 2 ml decahydronaphthalene was added. The acid detergent solution was heated to boiling and refluxed for 60 minutes. The sample was then filtered on a previously tarred gooch crucible. The filtered mat was broken up and washed with hot water twice followed by acetone until it was clear. Then the filtered was dried at 100°C for eight hours and weighed. ADF was calculated as follows (Van Soest, 1963; Van Soest & Wine, 1967):

$$\text{ADF\%} = \frac{\text{Wo} - \text{Wt}}{\text{S}} \times 100$$

Where:

WO = Weight of oven dry crucible including fiber

Wt = Tarred weight of oven dried crucible

S = Oven dried sample weight.

iii. Acid Detergent Lignin

Acid detergent lignin (ADL) was analyzed from lingo-cellulose (residue of ADF) following Georing & Van Soest (1970) and Waldern (1971). The cellulose was dissolved in 72% H_2SO_4. The remaining residue consisted of lignin and acid insoluble ash.

iv. Hemicellulose

The difference between neutral detergent fiber and acid detergent fiber is an estimate of hemicelluloses (Van Soest & Robertson, 1985).

Hemi cellulose = NDF – ADF.

7. Ethnobotany of Rangeland Plants

Plants were classified on the basis of local economic uses with special reference to fodder species fuel timber wood and medicinal uses. Information was based on personal observation supplemented with information gathered from 375 interviewee from the area. Study covered both the rural and urban area of District with an area of 409191 acres (1679 square km^2). District Tank was investigated for many Brick backing kilns, machine saw, farming activities, bread baking (Tandor owner) and for fuel wood trades. These are the major activities which consume sufficient amount of fire wood. Data for fodder and medicinal plants and their preferences was also gathered in the same way.

7.1 Fuel and Timber wood species

Data on the ethnobotany of fuel wood and timber wood species was gathered through a semi structured open questionnaire by interviewing 375 respondents in six different area of district Tank which directly or indirectly involved in utilization of plants. These included brick baking (Kilns owner), food seller (Tandor owner), tree fellers (tree cutter), farmers and fuel wood dealers following Ogunkunle & Oladele (2004) and Badshah *et al*. (2006). These respondents were selected as they were more knowledgeable by virtue of their profession, trades and utilization. The study was conducted during 2007 - 2009.

The information was also gathered on gender, age and educational background. The questionnaire sought the name of the preferred plant and quantity utilized. They were also asked to give the criteria as to why a particular plant species was considered best for fuel and timber wood. Fuel wood sellers were requested to quantify their weekly sales with reference to number of mounds (1 mound equal to 50 kg). The tree fellers were made to quantify their weekly cutting and removal on the number of average standard logs.

The Tandor owners and domestic users were requested to give information on the average number of donkey carts load utilized per week. While the farmers supplied the number of average sized tree removed during farming season.

i. Derivation of data

The average amount of wood consumed for various purposes/year and the quantity of wood removed from the forest / farms in the study area were first estimated in local units and then converted to metric tons in the following way.

A. The average consumption of single brick baking kilns is 3000 mounds per baking cycle and the number of cycles per year are 4. The number of wood in mounds are therefore 12000 per kilns. From the No of mounds in a year, the estimated quantity of wood in metric ton yr^{-1} was obtained by multiplying the appropriate factor (Number of Kilns × 3000 × 4).

B. The average carrying capacity of a tractor trolly is about 15 timber logs. Each log on the average weighs 5 mounds (0.25 metric tons). From the number of timber logs converted into various timber purposes in the machine saw and timber logs removed from the forest by tree feller in a week in metric tons yr^{-1} was obtained by multiplying with the appropriate factor (Number of logs per week × 5 x 52).(there are 52 weeks in a year).

C. The quantity of wood used by Tandor owners and domestic uses were estimated from the No of load of donkey cart consumed in a week. Donkey cart carry on average weight of about 5 mounds. This was then multiplied by appropriate factor i.e. (number of donkey cart x 5 x week in a year) to get estimation for whole year (Number of donkey cart x standard cart weight × 52).

D. One average size tree felled by farmers during farming season was observed to be equal to 2 donkey carts each weighing 5 mounds (0.25 metric tons). Only one farming season was seen in the study area. The estimated annual wood removed through this way was then obtained by using equation (2 × 0.25 × 1) to get actual no of trees felled in metric tons yr^{-1}

E. Fuel wood seller generally sell an average 20 mounds per week, therefore multiplying appropriate factor (20 × 52) obtained total sale in metric tons yr^{-1}.

ii. Timber wood and fuel wood utilization frequency

The frequency of timber wood species utilization was calculated as a percentage of number of interviewee (35 Saw machine) and that converting a specific plant into various timber uses/purposes. Similarly, the frequency of fuel wood species was obtained

3. Conservation Status of Plants

Plants were classified into various conservations classes using the IUCN (2001) criteria as follow:

Availability	**Collection**
0 = Uncommon or very rare	0 = More than 1000 kg/yr
1 = Less common or rare	1 = Consumed from 500-1000 kg/yr
2 = Occasional	2 = Consumed from 300-500 kg/yr
3 = Abundant	3 = Consumed from 100-200 kg/yr

Growth	**Part used**
0 = Regrowth in more 3 years	0 = Root/Whole plant
1 = Regrowth within 3 years	1 = Bark
2 = Regrowth within 2 years	2 = Seeds, Fruits
3 = Regrowth within 1 year	3 = Flowers
4 = Regrowth in a season	4 = Leaves/Gum/Latex

Total Score:

1. 0 - 4 Endangered:
2. 5 - 8 Vulnerable:
3. 9 - 12 Rare:
4. 13 - 14 Infrequent:
5. 15 - 16 Dominant

RESULTS AND DISCUSSION

FLORISTIC COMPOSITION

FLORISTIC COMPOSITION

1. Floristic composition and its ecological characteristics

Floristic diversity of a region is the total of the species within its boundaries, weather wild or cultivated, which is reflection of vegetation and plant resources. Plant resources are affected by agriculture, over grazing, anthropogenic interaction and natural disasters. The flora of District Tank consisted of 205 species of 56 families (Table 3). Of them, 159 species belonged to Dicot and 45 species to Monocot. *Equisetum* was the only Pteridophyte. Poaceae (34 Spp), Papilionaceae (19 Spp), Asteraceae (14 Spp), Chenopodiaceae (10 Spp) and Brassicaceae (9 Spp) were the leading families. They were followed by Euphorbiaceae (8 Spp), Boraginaceae, and Polygonaceae, each with 7 species. Amaranthaceae and Solanaceae had 6 species each. Mimosaceae and Malvaceae had 5 and 4 species, respectively. Asclepiadaceae and Zygophyllaceae each had 4 species. Each of the Apiaceae, Lamiaceae, Caryophyllaceae, Convolvulaceae, Moraceae and Plantaginaceae had 3 species. Rest of the 37 families either had two or less than 2 species. Poaceae, Papilionaceae, Asteraceae, Chenopodiaceae and Brassicaceae were the leading families. Malik & Malik (2004) also reported these families to be well represented in Kotli Hill during monsoon. Marwat & Qureshi (2000) and Durrani *et al.* (2005) also observed that these families were dominant in their respective studY areas. Some other studies also indicated similar results in Flora of Pakistan (Ali & Qaisar, 1995-2009) and abroad (Antije *et al.*, 2003; Eilu *et al.*, 2004). Our results are consistently supported by them as Poaceae, Asteraceae and Chenopodiaceae have emerged as the common families in the investigated area. Mendez (2005) and Muthuramkumar *et al.* (2006) also stated the abundance of same families in Laguna and Western Ghats. The members of Poaceae and Asteraceae due to their wide ecological amplitude are diverse in their habitat, occurrence.

The floristic list of Nara desert Bhatti *et al.* (2001), Qureshi & Bhatti (2005), Parveen *et al.* (2008), Qureshi & Bhatti (2008b) also reported high number of species in these families which also supports our finding. Both these families have also been reported to have more species than other families in flora of Chakwal (Hussain *et al.*, 2009). *Euphorbia* with 5 species was the largest genus followed by *Aristida* and *Chenopodium* each with 4 species. *Saccharum*, *Amaranthus*, *Heliotropium*, *Convolvulus*,

Prosopis, *Medicago* and *Plantago* each had 3 species. The remaining genera possessed one or 2 species (Table 3). These genera along with others are well represented in Pakistan (Nasir & Ali, 1971- 2007; Ali & Qaisar, 2009; Stewart, 1972). Some other studies also reported these genera having more species in other areas (Ferraz *et al*., 2004; Durrani *et al*., 2005; Pinheiro *et al*., 2006). Seasonal variation and climatic conditions are very much obvious in Pakistan. There are distinct spring, summer, autumn and winter seasons, all categorized by a definite range of temperature, rainfall and humidity. In Tank the summer is hot while winter is cold. Generally spring and summer have higher number of species than other season. Same was observed in the present study. Seasonal variations showed that spring had 138 species (67.3 %), followed by summer with 100 species (48.7%), winter 78 species (38.0%) and autumn 76 species (37.1%) (Table 4). Seasonality of climate has definitely shaped four aspect of the flora. Woody, shrubby, and some perennial herbs were common to all the seasons. The differences in different aspect were primarily due to the annuals, bulb bearing plants and some sporadic occasional ephemerals. Studies by Durrani *et al*. (2010) and Ahmad *et al*. (2009c) have also shown that spring and summer flora/ aspect have higher number of species than other aspects. This is what the present findings also reported.

Based on the habitat 140 (68.3%) species growing wild, were mesophytes including xerophytes. The flora was mostly composed of wild xerophytic plants. Similar results were obtained by Musila *et al*. (2003) and Gimenez *et al*. (2004). While 46 species (22.4%) were classified as hydrophytes, 10 species (4.8%) were found both in wet and dry conditions; and 9 species (4.6%) were cultivated for various purposes. There were 24 species (11.7%) with spiny nature. Spinescence is also an indicator of dry soil and environment. Among the perennial species, 19 were deciduous and 83 evergreen. The leaf lamina was simple in 152 species (74.1%), 5 species (2.4%) were leafless, while in the remaining 48 species (23.4%), it was compound or divided. Aphyllous species are also indicator of harsh environment. These species although five in our case, do tell the aridity of the area. Same species have been reported from other parts of Pakistan (Durrani *et al*., 2005; Badshah *et al*., 2006; Durrani *et al*., 2010) indicating some common features of the habitat. The ratio of herbaceous to woody/shrubby species was 4: 1. Sher *et al*.

(2003) also recorded similarly from Udigram Swat, Hussain *et al.* (2005) from Ghalegay Swat and Sher & Khan (2007) and Fazal *et al.* (2010) from District Haripur.

Although floristically many species were listed from the semiarid District Tank, however, quantitively they had limited distribution with restricted life cycle. A rich flora is the sign of high species diversity and species richness. Floristic composition is a qualitative feature that alone cannot reflect the true depiction of this semiarid zone, thus there is a need of quantitative consideration of the vegetation resources. Floristic composition is a better parameter of plant life, gene pool and diversity of plants in any area. The ecological behavior of plant like life form, leaf size spectra, phenology, habit and its ethnoecological potential is to be worked out.

2. Life form and its seasonal variation

The life form reflects physiognomy of the flora and vegetation, which is the result of all life processes in combination with environment. It helps in the recognition of ecological elucidation of vegetation. Life form of Raunkiaer (1934) classification is more reliable, which is based upon the principal of position and degree of protection to parenting bud during the unfavorable or adverse condition.

When Raunkiaerean classification was used, it was seen that overall therophytes (98 Spp., 47.8%) followed by hemicryptophytes (30 Spp., 14.6%) dominated the flora. Geophytes (24 Spp., 11.7%), chamaephytes (23 Spp., 11.2%), nanophanerophytes (17 Spp., 8.3%) and microphanerophytes (12 spp., 5.9%) were next in term of species. *Cuscuta reflexa* was the only parasitic plant (Table 5). Raunkiaer (1934) distinguished three major phytoclimates on the basis of life form on the earth. It includes phanerophytic climate in the tropics, therophytic in deserts and hemicryptophytic in the greater part of cold temperate zone. The present overall spectrum shows the dominance of therophytic flora. Biological spectra are important in comparing geographically and habitually widely separated plant communities and also considered as an indicator of prevailing environmental condition. Biological spectra changes due to biotic influences like agricultural practices, grazing, deforestation, trampling and climatic change.

Seasonal variation in life form indicated that in autumn the dominant life form was therophytic and nanophanerophytic each with 15 species (19.7%). It was followed by hemicryptophytes and microphanerophytes, respectively with 13 species (17.1%) and 12

species (15.7%). Chamaephytes with 11 species (14.4%) and geophytes with 9 species (11.8%) were next life form classes in autumn. *Cucuta reflexa* was the only parasitic species (Table 3, 4).

In winter season therophytes with 25 species (32.0%) dominated. Nanophanerophytes with 13 species (16.6 %), microphanerophytes 12 species (15.3%), hemicryptophytes 10 species (12.8%), chamaephytes 9 species (11.5%) and geophytes with 8 species (10.2 %) were next in order (Table 5).

During spring therophytes with 61 species (44.2%) emerged as dominant due to favorable growing season. Nanophanerophytes 16 species (11.5%), hemicryptophytes 14 species (10.1%), microphanerophytes 12 species (8.6%), chamaephytes 15 species (10.8%) and geophytes 19 species (13.7%) were next important life form classes.

During summer there were 37 species (37%) therophyte, 17 (17%) nanophanerophyte, 11 (11%) hemicryptophytes, 12 (12%) microphanerophytes, 14 (14 %) chamaephytes and 8 (8%) were geophytes (Table 5).

From the distribution of flora into various life form classes, it can be visualized that the flora and ultimately the vegetation might be stratified into tree layers composed of microphanerophytes, tall shrub layers composed of nanophanerophytes, a second low shrub layer consisting of chamaephytes and herbaceous layer formed by all herbaceous species including therophytes, geophytes, hemicryptophytes etc. Due to aridity, heavy deforestation and overgrazing a meaningful stratification cannot be seen except at certain localized protected places.

The life form spectra of flora and communities in the current study indicated that therophytes followed by hemicryptophytes dominated the flora. Geophytes, chamaephytes, nanophanerophytes and microphanerophytes were next in term of species. *Cuscuta reflexa* was the only parasitic plant. Cain & Castro (1959) and Shimwell (1971) reported that therophytes are characteristics of desert climate. Batalha & Martins (2002) reported that in Brazil the dominant life form was hemicryptophyte and phanerophytes which also in accordance with the present study. Gutkowski *et al*. (2002) also reported as in the present study.

The climate of the study area is semiarid type with almost level topography. The biological spectrum obtained in the present study reflects aridity. This area has scrub

vegetation with scattered trees. Species richness, life forms and dispersal modes of plants are related to altitudinal and rainfall gradients. The low percentage of tree species indicates intensive deforestation. The investigated area has the potential to support the growth of trees and shrubs yet human and cattle have degraded the overall floristic and vegetation.

Costa *et al*. (2007) reported that therophytes and phanerophytes are generally the most common life forms in south eastern Brazil a situation similar to the present findings. Hussain *et al*. (2009), Sher & Khan (2007) and Fazal *et al*. (2010) observed similar trends regarding prevalence of therophytes and hemicryptophytes in degraded and arid environment.

Generally in all the seasons and spring in particular therophytes and nanophanerophytes were dominant due to favorable growing season. During spring and early summer, there is always flush of annual plants. The dominance of therophytes occur due to unfavorable habitat conditions as suggested by others (Musila *et al*., 2003; Guo *et al*., 2009; Manhas *et al*., 2010) and our findings agree with them. Nazir & Malik (2006) reported that the biological spectrum of Sarsawa hill Kotli consisted of nanophanerophyte, therophytes and hemicryptophytes. The predominance of therophytes is reflected similar to the present study. In semi desert habitat of District Tank Chamaephytes were prominent partly because of saline soil and adverse climatic conditions.

Batalha & Martins (2002) also considered chamaephytes and therophytes as the major life form in unfavorable condition in desert and open physiognomies. In the investigated area hot and dry and waterlogged and saline condition coupled with over grazing lead to harsh condition. The results also agree with those of Sher & Khan (2007) who also stated that therophytes and nanophanerophytes were characteristics of subtropical habitats of Chagharzai Bunir. The findings of Kar *et al*. (2010) are also in line with our findings as they reported the dominance of therophyte and nanophanerophytes in grasslands of Odisha, India.

3. Leaf size spectra and its seasonal variation

The overall leaf size spectra showed that there were 46.8% (96 Spp) nanophylls, 27.8% (57 Spp) leptophylls, 17.1% (35 Spp) microphylls and 5.9 % (12 Spp) mesophylls.

While *Cuscuta reflexa, Capparis decidua, Periploca aphylla, P. calophlla* and *Equisetum arvense* (5 Spp., 2.4%) were aphyllous species (Table 5).

Seasonal variation in the leaf size spectra indicated that during spring nanophylls with 62 species (44.9%) was the dominant leaf size class. Leptophylls with 32 species (23.2%), microphylls 19 species (13.7%), mesophylls 10 species (7.2%) and aphyllous with 4 species (2.8%) were next in order. Nanophylls with 38 species (38%), leptophylls with 29 species (29%), microphylls with 19 species (19%) and aphyllous with 4 species (4%) were respectively present in summer. While in autumn nanophylls with 30 species (39.4%) and leptophylls with 26 species (34.2%) were major leaf size classes. Mesophyll 9 (11.8%), microphyll 7 (9.2%) and aphyllous with 4 species (2.6%) were next in order. During winter there were with 38 species (48.7%) nanophylls and 21 species leptophylls. Microphyllous 9 (11.5%) and mesophyllous 6 species (7.7%) were others leaf size classes. *Capparis decidua, Periploca aphylla, P. calophylla* and *Cuscuta reflexa* were aphyllous species in all the seasons (Table 5). Microphylls are usually characteristics of steppes, while nanophylls and leptophylls are characteristics of hot desert and saline habitats (Cain & Castro, 1959; Tareen & Qader, 1993; Husain *et al*., 2005). The present study recorded high % age of leptophylls during spring followed by nanophylls and microphylls. Dry and hot season had high percentage of nanonphylls.

Similarly, Sher & Khan (2007) reported high percentage of leptophylls and nanophylls from Chagarzai area. Species with small leaves are generally characteristics of dry and adverse habitats adapted to arid region (Nasir & Sultan, 2002).

Hussain & Chudhary (2009) reported higher percentage of microphyllous in contrast to our findings owing to moist environmental condition in Azad Kashmir. In dry habitats soil generally have poor nutrients contents due to which roots feel difficulty in absorbing soil moisture as in the present study, encouraging leptophyllous and nanophyllous vegetation.

In the present study it was observed that proportion of various leaf size classes change seasonally owing to presence of annuals and bulbous geophytes. However, the perennials and evergreens almost retained the same status in all the seasons. *Batalha & Martins (2004) also observed that leaf size is positively related to drought and soil condition. Malik et al. (2007) and Badshah et al. (2010a) reported microphyllous and*

nanophyllous as the dominant leaf size from Kotli Azad Kashmir and Waziristan. This disagreement is mainly due to altitudinal variation in climate and habitat condition. The situation in our case is generally xeric with saline patches. The size of leaves alone could not be used to identify specific leaf zone or climates. Other feature of plants such as habit and root system might also play important role.

4. Phenological behavior

Phenology is the study of the seasonal occurrence of developmental or life cycle events, such as bud break, flowering, or autumn leaf drop (Kafak *et al*., 2009). Phenology is periodic phenomenon that is tied to periodic environmental changes. The plant or flora as a whole exhibited seasonal phenologic contrast due to climatic variability (Table 6). Three flowering seasons were recorded in the area. The first flowering spell extended from March to May. During this flowering spell 126 species (61.5%) flowered. Of them, 110 species (87.3%) were herbs, 9 species (7.1%) were shrubs and 7 species (5.5%) were trees (Table 6). The second blooming period from June to September had blooming of 59 species (28.8%). Of them, 36 species (61.0%) were herbs, 20 species (34.5%) were shrubs and 3 species (5.2%) were trees. The third flowering spell lasting from December to February was represented by 19 herbaceous (9.3%) species only. *Equisetum arvense* did not produce spore body or spores.

The species varied in their phenologic events, during different times of the year. The present study showed that the growing season started at the end of March and extended to May during which majority plants produced flowers. Zhang *et al*. (2007) stated that warmth in weather condition generally advances spring vegetation phenology. However, the delayed responses flora phenology to rising temperature and their mechanisms are poorly understood. This agrees with our findings because in this semiarid zone temperature sufficiently increases during these months. Few plants bloomed during December to February. These included *Malcolmia scorpioides*, *Malvastrum coromendelianum*, *Lathyrus sativus*, *Emex spinosus* and *Cicer arietinum*. Lacey *et al*. (2003) reported that *Plantago lanceolata* flower during early summer which strengthens our findings. The flowering reached to its peak during March as 64 species (31.2 %) blossomed. These findings are in contrast with Malik *et al*. (2007) who recorded that July and August was the peak flowering months.

Tables 6, 7 show that as a whole the month of March had the peak flowering season, as 64 species (31.2 %) blossomed. The percentage of flowering species was 29 (14.1%), 33 (16.1%), 16 (7.6), 25 (12.2%), 17 (8.3%), 14 (6.8%) and 4 (2.0%) respectively during April, May, June, July, August, December and February. Flowering species generally decreased from spring to winter season. Flowers initiation and development and other growth activities are generally at the peak during rainy and early spring season in semi-arid Caatinga (Rocha *et al*., 2004), which are in line to our findings. In our case mild seasons had maximum flowering. Golluscio *et al*. (2005) reported that grasses had higher autumn-winter phenological activity than non-grass groups which differed in the date of beginning of vegetative growth and ending of the reproductive growth. In our case too most of the grasses bloomed in autumn and early winter.

When fruiting species were considered (Tables 6, 7), it was seen that majority of the plants, i.e.116 species (56.6 %) were in fruiting stage from April to June, followed by 67 species. (32.6%) from August to October and the rest 21 species (10.2%) produced fruits in various months of the year. The month of April had the peak of fruiting season as 62 species (30.2%) were in fruiting stage. The percentage of fruiting species was 20 (9.7%) in May, 34 (16.5%) in June, 6 (2.9%) in July, 27 (13.2%) in August and 34 (16.5%) in September. Few (10 species, 4.8%) produced fruits in February and (4 species, 2.0%) in March. *Emex australis* the only species possessed fruits in January (Tables 6, 7).

The major bulk of the flora i.e.113 species (55.1%) were in vegetative phase during the months of February to May and 64 species (31.2 %) from October to December. The seedlings of 9 species (4.3%) including *Prosopis cineraria, Convolvulus arvensis, Cynodon dactylon, Taraxacum officinale, Datura alba, Desmostachya bipinata, Tricholeps chaetoleps* and *Urtica pilulifera* could be seen throughout the year. Ten species (4.8%) including *Celtis eriocarpa, Collegonum polygonoides, Periploca aphylla, Vitex negundo* and *Equisetum arvensis* etc. could not be observed in seedling stage. The remaining 9 species (4.3%) germinated in various months (Table 6).

Two dormant seasons were obvious in the investigated area (Table 7). The first dormant period had the majority of the species i.e.117 species (57.2%) from October to

December while in the second spell 82 species (40.0%) remained dormant from June to August. Five species (2.4%) were inactive in various months. Over all the month of July was the peak dormant period as 68 of the species (33.2%) exhibited inactive in this month. It was followed by October where 58 species (28.3%) were dormant and 46 species (22.4%) became dormant in December (Table 7).

The fruiting during dry and winter season is probably related to the fact that beginning of the next rainy period will offer favorable condition for seed germination due to global climate change (Walther, *et al*., 2002). Another study stated (Morellato, 2003) that fruiting started at the end of April and beginning of May. Fruiting was more intense during dry season. Vliet *et al*. (2006) pointed out that this period had the advantage of providing the seed with intense luminosity and thus greater probability to germinate. The month of April had the peak of fruiting season as 62 species (30.2%) were in fruiting stage. This is in contrast to Kikim & Yadav (2001) and Yadav & Yadav (2008) who reported that majority of the woody species exhibited fruiting during September. In our case there were much annuals and grasses that flowered and produced seeds/fruits in a flush. Phenological analysis provides knowledge about the pattern of plant growth and development as well as the effects of environment and selective pressures on flowering and fruiting behavior (Zhang *et al*., 2006). Kushwaha & Singh (2005) suggested that climate change causes deviations in the length of growing period. Few species (4.8%) produced fruits in February and March. *Emex australis* was the only species having fruits in December and January. This is in line with Jadeja & Nakar (2010) who observed that fruiting activity was maximum in December month as 50% species produced fruits in their study area. Duration of maturation of leaves was shortest but that of fruit ripening was longest in most of the species. Seasonal variation in the number of species flowering and fruiting generally is consistent with the hypothesis that seasonal variation in irradiance limits the evolution of reproductive phenologies (Zimmerman *et al*., 2007). In the present case the peak month of April, for fruiting indicated that area is semiarid with extreme temperature unsuitable for annual plants. This is in line with the findings of Osada *et al*. (2003) who stated that fruiting and flowering is particularly abundant around April and may.

Two dormant seasons were obvious in the investigated area. The first dormant period had the majority of the species (57.2%) from October to December while in the second spell (40.0%) remained dormant from June to August. This is in contradiction with Jadeja & Nakar (2010) who reported that leaf fall in most of species occurred during January, new leaves started coming before monsoon from February to March. In the present case extreme of low temperature in (November and December) and high in (My - August) were observed where by plants shown leaf fall.

Plant phenologies are the outcome of relations of biotic and climatic factors that through natural assortment decide the most proficient timing for growth and resprouting (Nath *et al*., 2008). In our case too it was generally observed that in October the temperature slowly decreased to facilitate leaf fall and in June along with high temperature there is pressure of grazing and browsing which facilitate the second dormant phase.

The grazing period must coordinated with phenological cycle. Grazing is allowed at vegetative stage when shrubs and trees shed the seeds. The grazing of annual and herbaceous prior to flowering will restrict their population as seeds are the only means of survival and regeneration. Phonological studies also depict the suitable season for harvesting seeds and fruits. In the present such an activity could be performed twice a year for the desired species.

5. Ethnobotanical Profile

Plant- animal including human interaction can never be separated right from the birth till death as dependence is obligate. Therefore, the plant resources lead to the economic wealth of an area. It is the utility and use of plants that make the plants important in the area. In the same context when the plants of District Tank were analyzed, it was observed that all the 205 recorded species had varied local uses for various purposes (Table 8). These species included 166 herbs, 29 shrubs and 10 trees. The major bulk of 142 species (69.3%) was classified as fodder/forage. This clearly suggests that the area is more suitable for rangeland. Poor vegetation and dry hot condition cannot support agriculture. Most of the recorded species in this study have also been reported as fodder species by other workers (Hussain *et al*., 2004, 2006; Badshah *et al*., 2006; Kappelle *et al*., 2000; Tordio *et al*., 2006; Arenas & Scarpa, 2007; Maoe *et al*.,

2009; Ajaib *et al*., 2010). The present findings regarding the similarity in use of plants as fodder agree with them.

The next major utility of plant i.e. 49 species (22.4%), was their medicinal uses. Medicinal plants are invariably used in local health system in these traditional societies. With increasing dependency, there was an increasing exploitation of medicinal plants by local folk, collectors and herbal drug dealers. Grazing, browsing and deforestation of plant resource has caused a drastic decrease in the medicinal flora. The preferred medicinal plants like *Citrullus colocynthis*, *Withania coagulans* and *Periploca aphylla* now grow only within thickets of spiny shrubs or in inaccessible locations. Prior to this study no reference exists on medicinal aspect of this area. However, Gilani *et al*. (2003), Wazir *et al*. (2004), Jabar *et al*. (2006), Ishtiaq *et al*. (2007), Hussain *et al*. (2008), Sardar & Khan (2009) and Tareen *et al*. (2010) reported these plants to be medicinal from other areas of Pakistan. Macia (2004), Okello & Sesgawa (2007), Miah *et al*. (2009), and Meena & Yadava (2010) listed various plants and their traditional medicinal uses from other parts of the world.

In the investigated area most of the people are poor and lack basic facilities. The locals mostly depend upon local flora for fuel and timber wood. There were 36 species used as fuel wood and 11 species for timber purpose. These include *Acacia nilotica*, *Salsola foetida*, *Suaeda fruticosa*, *Prosopis cineraria*, *Prosopis juliflora*, *Prosopis farcta*, *Tamarix aphylla*, *T. dioica* and *Zizyphus nummularia* etc for domestic fuel purpose. There is tremendous pressure for fuel wood on these rangeland due to increasing population and inflect of internally displaced person (IDPS) from Waziristan since 2008. In winter local people have to keep their homes warm against chilling. Grazing and collection of medicinal plants coupled with fuel wood and timber collection have severally hampered the regeneration capacity of these species. Ibrar *et al*. (2007) in Shangla, Khan & Khatoon (2007) in Gilgit, Hussain *et al*. (2008) in Sahiwal, Sardar & Khan (2009) in Narowal and Qasim *et al*. (2010) in Lasbela reported miscellaneous use of various plants which are in accordance with our findings.

There are 7 species (3.4%) used as edible fruits, 9 species (4.4%) as vegetables and 5 species (2.4%) as condiments. The leaves of *Amaranthus viridis*, *A. spinosus*, *A. graecizans*, *Chenopodium morale* and *Allium sativum* are used as vegetable and

condiments. Twelve species (5.8%) were used as roof thatching and 3 species (1.5%) including *Dalbergia sissoo* were used for furniture making. Many plants had multiple uses such as *Acacia modesta, Acacia nilotica ssp. nilotica* and *Zizyphus mauritiana* etc. which are used as fodder, timber wood, fire wood, medicinal and also had other varied uses. These plants are used in individual form or in combination with other species or other edible items. The details of which are provided under subsequent section on ethnobotany.

The major utility of this ecosystem could be pasture, therefore efforts be directed to improve the area as a rangeland. This will automatically conserve over all vegetation resources. The investigated area is faced with problem like deforestation, overgrazing, and over exploitation of medicinal and fuel wood species. A plant subjected to multiple pressure viz. grazing, medicinal utility and fuel wood is under immense biotic pressure that arrests its spread and surviving capability. The poor vegetation cover and non productive land has promoted soil erosion that has further deteriorated the habitat. Besides, scientific approach awareness among the local inhabitants encouraged.

The roof of the local mud or brick houses and shelters for livestock are generally made from local material. These include *Typha*, *Capparis* and *Saccharum* etc. The use of plants for roof thatching from adjoining areas has been reported by other workers (Sardar & Khan, 2009; Ajaib *et al*., 2010; Qasim *et al*., 2010). The furniture wood consisting of *Dalbergia sissoo* is also valuable source of earning to meet their own demands. Some of these plants with similar uses have been reported by Qureshi *et al*. (2007), Hussain *et al*. (2004) and Shah & Hussain (2008).

Timber wood harvest from forest resources has become one of the major ecological problems. In the recent ongoing Taliban crises when most of the facilities/resources are not available to the IDPS, the pressure got mounted on woody species for burning and construction material. This has lead to creation of barren areas. Plants such as *Acacia nilotica*, *Tamarix aphylla* and *Zizyphus mauritiana* and *Prosopis farcta* are highly valuable as timber wood for high selling and buying prices.

Table 3. Floristic list, seasonal composition, biological and leaf size spectrum of plants of District Tank.

S. No.	Division / Family / Species	Habitat	Seasonality				Life form	Leaf size	Lamina	Spinescence
			A	W	S	Sm				
	A. PTERIDOPHYTA									
	1. Equisetaceae									
1	*Equisetum arvense* L.	W	-	-	+	-	G	Ap	Abs	-
	B. MONOCOTYLEDONS									
	2. Alliaceae									
2	*Allium sativum* L.	C	-	+	+	-	G	N	S	-
3	*Allium cepa* L.	C	-	+	+	-	G	N	S	-
	3. Arecaceae									
4	*Phoenix dactylifera* L.	W & D	+	+	+	+	Mp	Mes	Com	-
	4. Asphodelaceae									
5	*Asphodelus tenuifolius* Cav.	D	-	+	-	-	G	L	S	-
	5. Cypraceae									
6	*Cyprus difformis* L.	W	-	+	+	-	G	N	S	-
7	*Cyprus rotundus* L.	W	+	+	-	+	G	N	S	-
	6. Juncaceae									
8	*Juncus bufonius* L.	W	-	-	+	+	G	L	S	-
9	*Juncus inflexus* L.	W	-	-	+	+	G	L	S	-

7. Poaceae										
10	*Aristida adscensionis* L.	D	+	-	-	-	H	Mic	S	-
11	*Aristida cyanantha* Nees ex Steud.	D	-	-	-	+	H	Mic	S	-
12	*Aristida mutabilis* Trin. & Rupr.	D	+	+	+	-	Th	N	S	-
13	*Aristida triticoides* Henr.	D	+	-	-	-	H	N	S	-
14	*Avena sativa* L.	D	-	+	-	-	Th	N	S	-
15	*Cenchrus biflorus* Roxb.	D	+	+	-	-	H	L	S	-
16	*Cenchrus ciliaris* L.	D	-	+	-	+	H	L	S	-
17	*Cymbopogon jwarancusa* (Jones) Schult.	D	-	-	+	-	H	N	S	-
18	*Cynodon dactylon* (L.) Pers.	W & D	+	+	+	+	H	L	S	-
19	*Dactyloctenium aegyptium* (L.) Willd.	D	-	+	-	-	Th	Mic	S	-
20	*Desmostachya bipinnata* (L.) Stapf.	D & W	+	-	+	-	H	N	S	-
21	*Dichanthium annulatum* (Forssk.) Stapf.	D & W	-	+	-	-	H	N	S	-
22	*Echinochloa colona* (L.) Link.	D	-	+	+	-	Th	N	S	-
23	*Echinochloa crus-galli* (L.) Beauv.	D	-	-	-	+	Th	N	S	-
24	*Eragrostis cilianensis* (All.) Lut. ex F.T.	D	-	-	+	+	H	N	S	-
25	*Eragrostis minor* Host.	D & W	-	-	+	-	Th	N	S	-
26	*Imperata cylindrica* L.	W	+	-	+	-	G	L	S	-
27	*Ochthochloa compressa* (Forssk.) Hilu	D	-	-	+	-	H	N	S	-

28	*Oryza sativa* L.	C	-	-	-	+	Th	Mic	S	-
29	*Panicum antidotale* Retz.	D	+	-	-	-	H	N	S	-
30	*Panicum capillare* L.	D	-	-	+	-	Th	N	S	-
31	*Phalaris aquatica* L.	W	-	-	-	+	G	N	S	-
32	*Phragmites karka* (Retz.) Trin. ex Steud.	W	+	-	+	+	Ch	Mes	S	-
33	*Poa annua* L.	W	-	+	+	-	Th	L	S	-
34	*Poa infirma* H. B. K.	W	-	-	-	+	Th	L	S	-
35	*Polypogon monspeliensis* (L.) Desf.	W	-	-	+	-	Th	Mic	S	-
36	*Saccharum bengalense* Retz.	D & W	+	-	+	+	Ch	N	S	-
37	*Saccharum munja* Roxb.	D	+	-	-	-	Ch	N	S	-
38	*Saccharum spontaneum* L.	D	+	+	-	-	Ch	L	S	-
39	*Schismus barbatus* (L.) Thell.	W	-	+	-	-	H	N	S	-
40	*Sclerochloa dura* (L.) P. Beauv.	D	-	-	+	+	Th	N	S	-
41	*Setaria verticillata* (L.) P. Beauv.	D	-	+	-	-	Th	L	S	-
42	*Triticum aestivum* L.	C	-	+	+	+	Th	Mic	S	-
43	*Zea mays* L.	C	-	-	-	+	Th	Mes	S	-
8. Typhaceae										
44	*Typha latifolia* L.	W	+	+	+	+	G	Mes	S	-
45	*Typha minima* Funck ex Hoppe	W	+	-	-	+	G	Mes	S	-

C. DICOTYLEDON										
1. Aizoaceae										
46	*Trianthema portulacastrum* L.	D	-	-	-	+	Th	N	S	-
2. Amaranthaceae										
47	*Achyranthes aspera* L.	D	+	-	-	-	Th	N	S	Sp
48	*Aerva javanica* (Burm. f.) Juss.	D	+	+	+	+	Ch	L	S	-
49	*Aerva lanata* (L.) Juss. ex Schult.	D	+	+	+	+	Ch	L	S	-
50	*Amaranthus graecizans* L.	D	-	-	-	+	Th	L	S	-
51	*Amaranthus spinosus* L.	D	-	-	+	-	Th	N	S	Sp
52	*Amaranthus viridis* L.	D	+	-	-	-	Th	N	S	-
3. Apiaceae										
53	*Anethum graveolens* L.	D	-	-	+	-	Th	L	Dis	-
54	*Psammogeton biternatum* Edgew.	D	-	-	+	+	Th	L	Dis	-
55	*Torilis japonica* (Houtt.) DC.	D	-	-	+	-	Th	N	Dis	-
4. Apocyanaceae										
56	*Nerium indicum* Mill.	W	+	+	+	+	Np	Mic	S	-
57	*Rhazya stricta* Decne.	D	-	-	+	+	Ch	N	S	-
5. Asclepiadaceae										
58	*Calotropis procera ssp. hamiltonii* (Wight) Ali.	D	+	+	+	+	Ch	Mes	S	-
59	*Oxystelma esculentum* (L. f.) R. Brown.	D	-	-	-	+	Ch	L	S	-

60	*Periploca aphylla* Decne.	D	+	+	+	+	Np	Ap	Abs	-
61	*Periploca calophylla* (Wight) Falc.	D	+	+	+	+	Np	Ap	Abs	-
	6. Asteraceae									
62	*Centaurea iberica* Trevir. ex Spreng.	D	-	-	+	-	Th	N	Dis	Sp
63	*Centaurea moschata* L.	D	-	-	+	-	Th	N	Dis	Sp
64	*Conyza canadensis* (L.) Cronquist	D	-	-	+	+	Th	Mic	S	-
65	*Cousinia minuta* Boiss.	D	-	-	-	+	Th	N	S	-
66	*Eclipta alba* (L.) Hassk.	W	+	+	+	-	G	N	S	-
67	*Filago arenaria* (Smoljan.) Chrtek & Holub	D	-	-	+	-	Th	L	S	-
68	*Ifloga spicata* (Forssk.) Sch. Bip.	D	-	-	+	-	Th	L	S	-
69	*Launaea nudicaulis* (L.) Hook.f.	D	+	-	+	-	Th	Mes	S	-
70	*Pulicaria crispa* (Forssk.) B.H.	D	-	-	-	+	H	L	S	-
71	*Sonchus asper* (L.) Hill	W	-	+	-	-	Th	Mic	Dis	-
72	*Sonchus oleraceus* L.	W	-	-	-	+	Th	Mic	Dis	-
73	*Taraxacum officinale* F. H. Wigg.	W	-	-	-	+	Th	Mic	S	-
74	*Tricholepis chaetolepis* (Boiss.) Rech. f.	D	-	-	+	-	Th	L	S	-
75	*Xanthium strumarium* L.	D	-	-	+	-	Th	N	S	Sp
	7. Boraginaceae									
76	*Arnebia hispidissima* (Lehm.) A. DC.	D	-	-	+	-	Th	L	S	-

77	*Arnebia guttata* Bunge	D	-	-	+	-	Th	L	S	-
78	*Cynoglossum lanceolatum* Forssk.	D	+	-	-	-	H	N	S	-
79	*Gastrocotyle hispida* (Forssk.) Bunge	D	-	+	-	-	H	Mic	S	-
80	*Heliotropium elipticum* Ledeb.	D	-	-	+	+	Th	N	S	-
81	*Heliotropium europaeum* L.	D	-	-	+	-	Th	Mic	S	-
82	*Heliotropium ovalifolium* Forssk.	D	-	-	+	+	Th	Mic	S	-
8. Brassicaceae										
83	*Brassica rapa subsp. campestris* (L.) Clapham.	C	-	+	+	-	Th	N	Dis	-
84	*Coronopus didymus* (L.) Smith	W	+	+	-	-	Th	Mic	Dis	-
85	*Crambe cordifolia* Steven	W	-	-	-	+	Th	Mic	S	-
86	*Farsetia hamiltonii* Royle.	D	-	-	+	+	Np	L	S	-
87	*Farsetia ramosissima* Hochst. ex Boiss.	D	-	-	+	+	Th	N	S	-
88	*Malcolmia africana* (L.) R. Br.	D	-	-	+	-	Th	N	S	-
89	*Malcolmia scorpioides* (Bunge) Boiss.	D	-	-	-	+	Th	Mic	S	-
90	*Matthiola incana* (L.) R. Br.	D	-	+	+	-	Th	Mic	S	-
91	*Sisymbrium irio* L.	D	-	-	+	+	Th	N	Dis	-
9. Campanulaceae										
92	*Campanula benthamii* Wall. ex Kitamura	W	-	-	-	+	Ch	N	S	-

93	*Campanula sulaimanii* E. Nasir.	W	-	-	+	-	Ch	N	S	-
10. Capparidaceae										
94	*Capparis decidua* (Forssk.) Edgew.	D	+	+	+	+	Np	Ap	Abs	Sp
95	*Cleome brachycarpa* Vahl ex DC.	D	-	+	-	-	Th	N	Com	-
11. Caryophyllaceae										
96	*Silene conoidea* L.	D	-	-	+	-	Th	N	S	-
97	*Spergula arvensis* L.	W	-	-	+	-	Th	N	S	-
98	*Spergularia marina* (L.) Griseb.	W	-	-	+	-	Th	L	S	-
12. Ceasalpinaceae										
99	*Cassia senna* L.	D	-	-	-	+	Ch	L	Com	-
13. Chenopodiaceae										
100	*Atriplex griffithii* Moq.	D	-	+	+	+	Np	N	S	-
101	*Chenopodium album* L.	D	-	+	+	-	Th	N	S	-
102	*Chenopodium ambrosioides* L.	W	-	-	+	-	Th	L	S	-
103	*Chenopodium murale* L.	D	+	-	-	-	Th	L	S	-
104	*Chenopodium nepalense* Colla	D	-	-	-	+	Th	N	S	-
105	*Halostachys belangerana* (Moq.) Botsch.	D	+	-	-	-	Np	L	S	-
106	*Haloxylon multiflorum* (Moq.) Bunge ex Boiss.	D	+	+	+	+	Ch	L	S	-
107	*Kochia indica* Wight	D	-	+	+	+	Th	L	S	-

108	*Salsola foetida* Del.ex Spreng.	D	+	+	+	+	Ch	L	S	-
109	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	D	+	+	+	+	Ch	L	S	-
14. Convolvulaceae										
110	*Convolvulus arvesis* L.	D	-	+	-	-	Th	N	S	-
111	*Convolvulus microphyllus* Sieb.ex Spreng.	D	+	-	-	+	Th	N	S	-
112	*Convolvulus prostrata* Forssk.	D	+	-	-	+	Th	L	S	-
15. Cucurbitaceae										
113	*Citrullus colocynthis* (L.) Schrad.	D	+	-	-	-	Th	Mic	Dis	-
16. Cuscutaceae										
114	*Cuscuta reflexa* Roxb.	D	+	+	+	+	P	Ap	Abs	-
17. Euphorbiaceae										
115	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	D	-	-	-	+	H	N	S	-
116	*Chrozophora tinctoria* (L.) Raf.	D	-	-	-	+	Th	Mic	S	-
117	*Euphorbia dracunculoides* Lam.	D	-	-	+	-	H	L	S	-
118	*Euphorbia granulata* Forssk.	D	+	-	-	-	H	L	S	-
119	*Euphorbia helioscopia* L.	D	-	-	+	-	Th	N	S	-
120	*Euphorbia prostrata* Ait.	D	+	-	+	-	Th	L	S	-
121	*Euphorbia thymifolia* L.	D	+	-	-	-	Th	L	S	-
122	*Ricinus communis* L.	D	-	-	+	+	Ch	Mes	S	-

18. Fumariaceae										
123	*Fumaria indica* (Hausskn.) Pugsley	D	-	+	-	-	Th	N	Dis	-
19. Gentianaceae										
124	*Centaurium spicatum* (L.) Fritsch	D	-	-	+	-	Th	N	Dis	-
125	*Centaurium pulchellum* (Sw.) Druce	D	-	-	+	-	Th	L	Dis	-
20. Hypericaceae										
126	*Hypericum perforatum* L.	D	-	+	-	-	Ch	N	S	-
21. Lamiaceae										
127	*Ocimum basilicum* L.	D	+	+	+	+	Ch	N	S	-
128	*Mentha longifolia* (L.) L.	W	-	+	+	-	G	N	S	-
129	*Mentha spicata* L.	W	-	+	+	-	G	N	S	-
22. Malvaceae										
130	*Abutilon bidentatum* Hochst.ex A. Rich.	D	+	+	+	+	Ch	N	S	-
131	*Malva neglecta* Wallr.	D	-	+	+	+	Th	Mic	S	-
132	*Malva parviflora* L.	D	-	-	+	+	Th	Mic	S	-
133	*Malvastrum coromandelianum* (L.) Garcke	D	-	-	+	-	H	N	S	-
23. Meliaceae										
134	*Melia azedarach* L.	D	+	+	+	+	Mp	N	Com	-

24. Mimosaceae										
135	*Acacia modesta* Wall.	D	+	+	+	+	Mp	L	Com	Sp
136	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	D	+	+	+	+	MP	L	Com	Sp
137	*Prosopis cineraria* (L.) Druce	D	+	+	+	+	Np	L	Com	Sp
138	*Prosopis farcta* (Banks & Sol.) Macbride.	D	+	+	+	+	Mp	L	Com	Sp
139	*Prosopis juliflora* Swartz.	D	+	+	+	+	Np	L	Com	Sp
25. Moraceae										
140	*Ficus carica* L.	D	+	+	+	+	Np	Mes	S	-
141	*Morus alba* L.	D	+	+	+	+	Mp	Mes	S	-
142	*Morus nigra* L.	D	+	+	+	+	Mp	Mes	S	-
26. Myrtaceae										
143	*Eucalyptus globulus* Labill.	D	+	+	+	+	Mp	N	S	-
27. Nyctiginaceae										
144	*Boerhavia diffusa* L.	D	-	+	-	-	H	N	S	-
145	*Boerhavia procumbens* Banks ex Roxb.	D	+	-	-	-	H	N	S	-
28. Oxalidaceae										
146	*Oxalis corniculata* L.	W	-	-	+	+	Th	N	Com	-

29. Papavaraceae										
147	*Hypecoum pendulum* L.	D	-	-	+	+	Th	L	Dis	-
30. Papilionaceae										
148	*Alhagi maurorum* Medic.	D	-	-	-	+	H	L	S	Sp
149	*Astragalus tribuloides* Delile	D	+	-	-	-	Ch	L	Com	Sp
150	*Astragalus amherstianus* Royle ex Benth.	D	-	-	+	-	Ch	L	Com	Sp
151	*Cicer arietinum* L.	C	-	-	+	-	Th	L	Com	-
152	*Crotolaria burhia* Buch.-Ham. ex Benth.	D	-	-	-	+	Np	L	S	-
153	*Cyamopsis tetragonoloba* (L.) Taubert	D	-	-	-	+	Th	N	Com	-
154	*Dalbergia sissoo* Roxb.	W & D	+	+	+	+	Mp	N	Com	-
155	*Lathyrus aphaca* L.	W	+	-	-	-	Th	N	Com	-
156	*Lathyrus sativus* L.	W	-	-	+	+	Th	N	Com	-
157	*Medicago minima* (L.) Grufb	W	-	-	+	+	Th	N	Com	-
158	*Medicago polymorpha* L.	W	-	-	+	-	Th	N	Com	-
159	*Medicago laciniata* (L.) Mill.	D	-	+	+	-	Th	N	Com	-
160	*Melilotus indica* (L.) All.	D	-	+	+	-	Th	N	S	-
161	*Melilotus alba* Desr.	D	-	-	+	+	Th	L	S	-
162	*Parkinsonia aculeata* L.	D	+	+	+	+	Np	N	Com	-

163	*Trifolium alexandrianum* L.	C	-	+	+	-	Th	N	Com	-
164	*Trifolium repens* L.	C	-	+	+	-	Th	N	Com	-
165	*Vicia faba* L.	D	-	-	+	-	Th	N	Com	-
166	*Vicia tetrasperma* (L.) Schreber.	D	-	-	+	+	Th	N	Com	-
31. Portulacaceae										
167	*Portulaca quadrifida* L.	D & W	-	-	+	-	Th	N	S	-
32. Plantaginaceae										
168	*Plantago ciliata subsp. lanata* (Boiss.) Rech.	D	+	-	-	+	Th	N	S	-
169	*Plantago lanceolata* L.	W	-	-	+	+	Th	N	S	-
170	*Plantago major* L.	W	-	-	+	+	Th	Mic	S	-
33. Polygonaceae										
171	*Calligonum polygonoides* L.	D	+	+	+	+	Np	L	S	-
172	*Emex australis* Steinh.	D	-	+	-	-	Th	Mic	S	Sp
173	*Emex spinosus* (L.) Campd.	D	-	-	+	-	Th	Mic	S	Sp
174	*Polygonum patulum* M. Bieb.	D	+	-	-	-	G	N	S	-
175	*Polygonum plebejum* R. Br.	D	-	+	+	-	H	N	S	-
176	*Rumex dentatus* L.	W	-	-	+	-	G	Mes	S	-
177	*Rumex obtusifolius* L.	W	+	-	+	-	G	Mic	S	-

34. Primulaceae										
178	*Anagallis arvensis* L.	W	-	-	-	+	Th	N	S	-
35. Ranunculaceae										
179	*Ranunculus muricatus* L.	W	-	-	+	-	G	Mic	Dis	-
180	*Ranunculus sceleratus* L.	W	-	-	+	+	G	Mic	Dis	-
36. Resedaceae										
181	*Oligomeris linifolia* (Vahl.) Macbride	D	-	-	+	-	Th	N	S	-
182	*Reseda odorata* L.	D	-	+	-	-	Th	N	S	-
37. Rhamnaceae										
183	*Zizyphus mauritiana* Lam.	D	+	+	+	+	Mp	N	S	Sp
184	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	D	+	+	+	+	Np	N	S	Sp
38. Salvadoraceae										
185	*Salvadora oleoides* Decne.	D	+	+	+	+	Np	N	S	-
39. Sapindaceae										
186	*Dodonaea viscosa* (L.) Jacq.	D	+	+	+	+	Np	N	S	-
40. Scrophulariaceae										
187	*Veronica aqutica* Bern.	W	-	-	+	-	G	N	Dis	-
188	*Veronica biloba* L.	W	-	-	+	-	Th	N	Dis	-

41. Solanaceae										
189	*Datura alba* Nees.	D	-	-	+	-	Th	Mic	S	Sp
190	*Hyoscyamus squarrosus* Griffith	D	-	-	+	+	Ch	Mic	S	Sp
191	*Solanum nigrum* L.	W & D	-	-	+	+	Th	Mic	S	-
192	*Solanum surattense* Burm. f.	D	+	-	-	-	H	N	S	Sp
193	*Withania coagulans* (Stocks) Dunal	D	+	+	+	+	Ch	Mic	S	-
194	*Withania somnifera* (L.) Dunal	D	-	-	+	+	Ch	Mic	S	-
42. Tamaricaceae										
195	*Tamarix aphylla* (L.) Karst	D	+	+	+	+	Mp	L	S	-
196	*Tamarix dioica* Roxb. ex Roth.	W	+	+	+	+	Np	L	S	-
43. Tiliaceae										
197	*Corchorus aestuans* L.	W	+	-	-	-	Th	L	S	-
44. Ulmaceae										
198	*Celtis eriocarpa* Decne.	D	+	+	+	+	Mp	N	S	-
45. Urticaceae										
199	*Urtica pilulifera* L.	W & D	-	-	+	-	G	Mic	S	-
46. Verbinaceae										
200	*Vitex negundo* L.	W	+	+	+	+	Np	N	Com	-
47. Violaceae										
201	*Viola stocksii* Boiss.	W	+	-	-	-	G	Mic	S	-

48. Zygophyllaceae										
202	*Fagonia indica* var. *schweinfurthii* Hadidi	D	+	+	-	-	Th	L	S	Sp
203	*Peganum harmala* L.	D	-	-	+	-	H	L	Dis	-
204	*Tribulus terrestris* L.	D	+	-	-	-	H	L	Com	Sp
205	*Tribulus pentandrus* Forssk.	D	-	-	+	-	H	L	Com	Sp

Key: D = Dry; W = Wet; C = Cultivated; A = Autumn; S = spring; W = Winter; Sm = Summer; Th = Therophyte; H = Hemicryptophyte; Ch = Chamaephyte; G = Geophyte; Np = Nanophanerophyte; Mp = Microphanerophyte;.P = Parasite L = Leptophyll; N = Nanophyll; Mic = Microphyll; Mes = Mesophyll; Ap = Aphyllous; S = Simple; Dis = Disected; Com = Compound; Abs = Absent; Sp = Spiny

Table 4. Summary of characteristics of flora of District Tank listed in Table 2.

S. No	Ecological characteristics	No	percentage
1	**Flora**		
i.	Total species	205	-
ii.	Family	56	-
iii.	Genera	142	-
2	**Seasonality/Aspect**		
i.	Autumn	76	19.4
ii.	Winter	78	19.9
iii.	Spring	138	35.2
iv.	Summer	100	25.5
3	**Habitat types**		
i.	Wet	46	22.4
ii.	Dry	140	68.3
iii.	Both	10	4.8
iv.	Cultivated	9	4.6
4	**Habit**		
i.	Ever green	83	40.5
ii.	Deciduous	19	9.3
iii.	Spiny	24	11.7
5	**Lamina shape**		
i.	Simple	152	74.1
ii.	Compound/ divided	48	23.4
iii.	Aphyllous	5	2.4
6	**Life form spectra**		
i.	Therophyte	98	47.8
ii.	Hemicryptophyte	30	14.6
iii.	Chamaephyte	23	11.2
iv.	Geophyte	24	11.7
v.	Nanophanerophyte	17	8.3
vi.	Microphanerophyte	12	5.8
vii.	Parasite	1	0.5
7	**Leaf size spectra**		
i.	Leptophyll	57	27.8
ii.	Nanophyll	96	46.8
iii.	Microphyll	35	17.1
iv.	Mesophyll	12	5.8
v.	Aphyllous	5	2.4

Table 5. Seasonal variation in life form and leaf size spectra of plants of District Tank.

Parameters		Season							
		Autumn		Winter		Spring		Summer	
		No	% age	No	% age	No	% age	No	% age
A. Life form									
1	Therophyte	15	19.7	25	32	61	44.2	37	37
2	Hemicryptophyte	13	17.1	10	12.8	14	10.1	11	11
3	Chamaephyte	11	14.5	9	11.5	15	10.9	14	14
4	Nanophanerophyte	15	19.7	13	16.7	16	11.6	17	17
5	Microphanerophyte	12	15.8	12	15.4	12	8.7	12	12
6	Geophyte	9	11.8	8	10.2	19	13.8	8	8
7	Parasites	1	1.3	1	1.3	1	0.7	1	1
	Total	76	100	78	100	138	100	100	100
B. Leaf size									
1	Leptophyll	26	34.2	21	26.9	32	23.2	29	29
2	Nanophyll	30	39.5	38	48.7	62	44.9	38	38
3	Microphyll	7	9.2	9	11.5	19	13.8	19	19
4	Mesophyll	9	11.8	6	7.7	10	7.2	10	10
5	Aphyllous	4	2.6	4	5.3	4	2.8	4	4
	Total	76	100	78	100	138	100	100	100

Table 6. Phenological behavior of Flora of District Tank.

S. No	Species	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	A .Trees												
1.	*Acacia modesta* Wall.	-	-	-	V	FL	FR	-	-	-	PR	-	-
2.	*Acacia nilotica ssp. nilotica* (L.) Wid. ex Delile	-	-	-	-	V	-	-	FL	FR	-	PR	-
3.	*Dalbergia sissoo* Roxb.	-	V	-	FL	FR	-	-	-	-	-	PR	-
4.	*Eucalyptus globulus* Labill.	-	V	FL	FR	-	-	-	-	-	PR	-	-
5.	*Morus alba* L.	-	V	FL	FR	-	-	-	-	-	PR	-	-
6.	*Morus nigra* L.	-	V	FL	FR	-	-	-	-	-	PR	-	-
7.	*Phoenix dactylifera* L.	-	-	-	FL	-	-	FR	-	-	PR	-	V
8.	*Prosopis farcta* (Banks & Sol.) Macbride.	-	-	V	-	FL	-	FR	-	-	-	-	PR
9.	*Tamarix aphylla* (L.) Karst	-	-	-	V	-	-	-	FL	-	FR	-	PR
10.	*Zizyphus mauritiana* Lam.	-	-	-	FR	-	PR	-	V	-	FL	-	-
	B .Shrubs												
11.	*Abutilon bidentatum* Hochst.ex A. Rich.	-	-	V	-	-	-	-	FL	FR	PR	-	-
12.	*Aerva javanica* (Burm. f.) Juss. ex Schult.	-	-	V	-	-	FL	-	-	FR	-	-	PR
13.	*Aerva lanata* (L.) Juss. ex Schult.	-	-	V	-	-	FL	-	-	FR	-	-	PR
14.	*Atriplex griffithii* Moq.	-	-	V	-	-	-	-	FL	-	FR	-	PR

15.	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	-	-	V	-	FL	-	-	FR	-	-	-	PR
16.	*Capparis decidua* (Forssk.) Edgew.	-	-	-	V	-	-	-	FL	-	FR	-	PR
17.	*Cassia senna* L.	-	-	V		FL	FR	-	-	-	PR	-	-
18.	*Celtis eriocarpa* Decne.	-	-	-	FL	-	-	-	FR	-	PR	-	-
19.	*Calligonum polygonoides* L.	-	-	-	-	-	FL	-	-	FR	-	-	PR
20.	*Crotolaria burhia* Buch.-Ham. ex Benth.	-	-	-	-	FL	-	-	FR	-	-	-	PR
21.	*Dodonaea viscosa* (L.) Jacq.	-	-	V	FL	-	FR	-	-	-	-	-	PR
22.	*Ficus carica* L.	-	-	V	-	-	FL	FR	-	-	PR	-	-
23.	*Haloxylon multiflorum* (Moq.) Bunge.ex Boiss.	-	-	-	V	-	FL	-	FR	-	-	-	PR
24.	*Kochia indica* Wight	-	-	-	V	-	FL	-	FR	-	-	-	PR
25.	*Melia azedarach* L.	-	-	V	-	FL		-	FR	-	-	-	PR
26.	*Nerium indicum* Mill.	-	-	V	FL	-	FR	-	-	-	PR	-	-
27.	*Parkinsonia aculeata* L.	-	-	-	FL	-	-	FR	-	-	PR	-	-
28.	*Periploca aphylla* Decne.	-	-	-	-	-	-	-	FL	FR	-	-	PR
29.	*Periploca calophylla* (Wight) Falc.	-	-	-	-	-	-	FL	-	FR	-	-	PR
30.	*Prosopis cineraria* (L.) Druce	-	-	FL	-	-	-	-	FR	-	-	-	PR
31.	*Prosopis juliflora* Swartz	-	-	-	-	V	FL	FR	-	-	-	PR	-
32.	*Rhazya stricta* Decne.	-	-	V	-	-	-	FL	FR	-	-	-	PR

33.	*Salsola foetida* Del.ex Spreng.	-	V	-	-	-	-	-	FL	FR	-	-	PR
34.	*Salvadora oleoides* Decne.	-	-	-	-	-	-	FL	-	FR	-	PR	-
35.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	-	V	-	-	-	-	-	FL	FR	-	-	PR
36.	*Tamarix dioica* Roxb. ex Roth.	-	-	-	V	-	-	-	FL	-	FR	-	PR
37.	*Vitex negundo* L.	-	-	-	-	-	-	FL	-	FR	-	PR	-
38.	*Withania coagulans* (Stocks) Dunal	-	-	-	V	-	-	-	FL	FR	-	-	PR
39.	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	-	-	-	-	V	-	FL	-	FR	-	-	PR
	C. Herbs												
40.	*Achyranthes aspera* L.	-	-	V	-	-	-	-	FL	-	FR	-	PR
41.	*Alhagi maurorum* Medic.	-	PR	-	-	V	-	-	-	FL	FR	-	-
42.	*Allium cepa* L.	-	-	FL	-	FR	-	PR	-	-	V	-	-
43.	*Allium sativum* L.	-	-	FL	-	FR	-	PR	-	-	V	-	-
44.	*Amaranthus graecizans* L.	-	-	V	FL	FR	-	-	-	-	PR	-	-
45.	*Amaranthus spinosus* L.	-	-	-	-	V	-	FL	FR	-	PR	-	-
46.	*Amaranthus viridis* L.	-	-	-	-	V	-	FL	FR	-	PR	-	-
47.	*Anagallis arvensis* L.	-	-	-	V	FL	FR	-	-	-	-	PR	-
48.	*Anethum graveolens* L.	-	V	FL	FR	-	-	-	-	-	PR	-	-
49.	*Aristida adscensionis* L.	-	-	-	-	-	V	-	FL	FR	-	-	PR
50.	*Aristida cyanantha* Nees ex Steud.	-	-	V	FL	FR	-	-	-	-	PR	-	-

51.	*Aristida mutabilis* Trin. & Rupr.	-	-	-	-	-	V	-	FL	FR	-	-	PR
52.	*Aristida triticoides* Henr.	-	-	-	-	-	V	FL	-	FR	-	PR	-
53.	*Arnebia hispidissima* (Lehm.) A. DC.	-	V	FL	FR	-	-	PR	-	-	-	-	-
54.	*Arnebia guttata* Bunge	-	V	FL	FR	-	-	PR	-	-	-	-	-
55.	*Asphodelus tenuifolius* Cav.	-	-	FL	FR	-	-	PR	-	-	-	V	-
56.	*Astragalus amherstianus* Royle ex Benth.	-	-	FL	FR	-	-	PR	-	-	-	V	-
57.	*Astragalus tribuloides* Delile	-	-	FL	FR	-	-	-	PR	-	-	V	-
58.	*Avena sativa* L.	-	-	FL	FR	-	PR	-	-	-	-	V	-
59.	*Brassica rapa* subsp. *campestris* (L.) Clapham	-	FR	PR	-	-	-	-	-	-	V	-	FL
60.	*Boerhavia diffusa* L.	-	-	FL	FR	-	-	PR	-	-	-	V	-
61.	*Boerhavia procumbens* Banks ex Roxb.	-	-	FL	FR	-	-	PR	-	-	-	V	-
62.	*Campanula benthamii* Wall. ex Kitamura	-	-	V	-	FL, FR	-	-	-	-	PR	-	-
63.	*Campanula sulaimanii* E. Nasir	-	-	V	-	FL	FR	-	-	-	PR	-	-
64.	*Cenchrus ciliaris* L.	-	-	V	FL	FR	-	-	-	-	PR	-	-
65.	*Cenchrus biflorus* Roxb.	-	-	-	-	-	V	FL	FR	-	-	-	PR
66.	*Centaurea iberica* Trevir. ex Spreng.	-	-	V	-	FL	FR	-	-	-	PR	-	-
67.	*Centaurea moschata* L.	-	V	FL	-	FR	-	PR	-	-	-	-	-
68.	*Centaurium pulchellum* (Sw.) Druce	-	-	V	-	-	FL	FR	-	-	-	-	PR

69.	*Centaurium spicatum* (L.) Fritsch	-	-	V	-	FL	FR	-	-	-	PR	-	-
70.	*Chenopodium album* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
71.	*Chenopodium ambrosioides* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
72.	*Chenopodium murale* L.	-	-	-	-	-	V	FL	-	FR	-	-	PR
73.	*Chenopodium nepalense* Colla	-	-	-	-	-	V	FL	-	FR	-	-	PR
74.	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	-	-	V	-	FL	FR	-	PR	-	-	-	-
75.	*Chrozophora tinctoria* (L.) Raf.	-	-	V	-	FL	FR	-	PR	-	-	-	-
76.	*Cicer arietinum* L.	-	FL	FR	-	PR	-	-	-	-	V	-	-
77.	*Citrullus colocynthis* (L.) Schrad.	-	-	-	-	V	-	FL	-	FR	-	-	PR
78.	*Cleome brachycarpa* Vahl ex DC.	-	FR	-	-	-	-	PR	-	V	-	-	FL
79.	*Convolvulus arvensis* L.	-	-	FL	FR	-	-	PR	-	-	-	-	-
80.	*Convolvulus microphyllus* Sieb.ex Spreng.	-	-	-	-	FL	FL	-	-	-	PR	-	-
81.	*Convolvulus prostratus* Forssk.	-	-	-	V	-	-	-	FL	FR	-	-	PR
82.	*Conyza canadensis* (L.) Cronquist	-	-	V	-	FL	FR	-	-	-	PR	-	-
83.	*Corchorus aestuans* L.		-	FL	FR	-	-	PR	-	-	-	-	V
84.	*Coronopus didymus* (L.) Smith	-	-	V	FL	-	FR	-	-	-	PR	-	-
85.	*Cousinia minuta* Boiss.	-	-	V	FL	-	FR	-	-	-	PR	-	-
86.	*Crambe cordifolia* Steven	-	-	V	FL	-	FR	-	-	-	PR	-	-
87.	*Cuscuta reflexa* Roxb.	-	-	FL	-	FR	-	-	-	-	PR	-	-

88.	*Cymbopogon jwarancusa* (Jones) Schult.	-	V	-	FL	-	FR	-	-	-	-	PR	-
89.	*Cyamopsis tetragonoloba* (L.) Taubert	-		FL	FR	-	-	PR	-	-	V	-	-
90.	*Cynoglossum lanceolatum* Forssk.	-	-	-	-	V	FL	-	-	FR	-	-	PR
91.	*Cynodon dactylon* (L.) Pers.	-	-	FL	FR	-	PR	-	-	-	-	-	-
92.	*Cyprus difformis* L.	-	-	V	FL	FR	-	-	-	-	PR	-	-
93.	*Cyprus rotundus* L.	-	FR	-	-	-	-	PR	-	-	V	-	FL
94.	*Dactyloctenium aegyptium* (L.) Willd.	-	-	V	-	FL	FR	-	-	-	PR	-	-
95.	*Datura alba* Nees	-	-	-	FL	-	FR	-	-	-	-	-	PR
96.	*Desmostachya bipinnata* (L.) Stapf.	-	-	-	-	-	FL	-	FR	-	-	-	PR
97.	*Dichanthium annulatum* (Forssk.) Stapf.	-	-	FR	-	-	-	PR	-	-	V	-	FL
98.	*Echinochloa colona* (L.) Link.	-	-	FR	-	-	-	PR	-	-	V	-	FL
99.	*Echinochloa crus-galli* (L) Beauv.	-	-	V	-	FL	FR	-	-	-	PR	-	-
100.	*Eragrostis minor* Host	-	-	V	-	-	FL	-	FR	-	-	-	PR
101.	*Eclipta alba* (L.) Hassk.	-	FR, PR	-	-	-	-	-	-	-	V	-	FL
102.	*Emex spinosus* (L.) Campd.	-	FL	FR	-	-	-	PR	-	-	-	V	-
103.	*Emex australis* Steinh.	FR	PR	-	-	-	-	-	-	-	V	-	FL
104.	*Equisetum arvense* L.	-	-	-	FR	-	-	PR	-	-	-	-	-
105.	*Eragrostis cilianensis* (All.) Lut. ex F.T.	-	-	FL	FR	-	-	PR	-	-	-	V	-
106.	*Euphorbia dracunculoides* Lam.	-	-	FL	FR	PR	-	-	-	-	-	-	V

107.	*Euphorbia granulata* Forssk.	-	-	-	-	V	-	FL	-	FR	PR	-	-
108.	*Euphorbia helioscopia* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
109.	*Euphorbia prostrata* Ait.	-	-	-	-	V	-	FL	-	FR	PR	-	-
110.	*Euphorbia thymifolia* L.	-	-	-	-	V	-	FL	-	FR	PR	-	-
111.	*Fagonia indica* var. *schweinfurthii* Hadidi	-	-	-	-	V	-	FL	-	FR	PR	-	-
112.	*Farsetia hamiltonii* Royle	-	-	V	-	FL	-	-	FR	-	PR	-	-
113.	*Farsetia ramosissima* Hochst. ex Boiss.	-	-	V	-	FL	-	-	FR	-	PR	-	-
114.	*Filago arenaria* (Smoljan.) Chrtek & Holub	-	-	V	-	FL	-	-	FR	-	PR	-	-
115.	*Fumaria indica* (Hausskn.) Pugsley	-	-	FL	FR	-	-	PR	-	-	-	V	-
116.	*Gastrocotyle hispida* (Forssk.) Bunge	-	FR	-	-	-	-	PR	-	-	-	V	FL
117.	*Halostachys belangerana* (Moq.) Botsch.	-	-	-	-	V	-	FL	-	FR	PR	-	-
118.	*Heliotropium elipticum* Ledeb.	-	-	-	-	V	-	FL	-	FR	PR	-	-
119.	*Heliotropium europaeum* L.	-	-	FL	FR	-	-	PR	-	-	-	V	-
120.	*Heliotropium ovalifolium* Forssk.	-	-	V	FL	-	FR	-	-	-	-	PR	-
121.	*Hyoscyamus squarrosus* Griffith	-	-	V	FL	-	FR	-	-	-	-	PR	-
122.	*Hypecoum pendulum* L.	-	-	V	FL	-	FR	-	-	-	-	PR	-
123.	*Hypericum perforatum* L.	-	FR	-	-	-	-	PR	-	-	-	V	FL
124.	*Imperata cylindrica* L.	-	-	-	-	V	-	FL	-	FR	PR	-	-
125.	*Juncus bufonius* L.	-	-	-	V	FL	-	-	FR	-	-	PR	-
126.	*Juncus inflexus* L.	-	-	-	V	FL	-	-	FR	-	-	PR	-

127.	*Lathyrus aphaca* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
128.	*Lathyrus sativus* L.	-	FL	-	FR	-	-	PR	-	-	V	-	-
129.	*Launaea nudicaulis* (L.) Hook. f.	-	-	-	-	V	-	FL	-	FR	PR	-	-
130.	*Malcolmia scorpioides* (Bunge) Boiss.	-	FL	-	FR	-	-	PR	-	-	-	V	-
131.	*Malcolmia africana* (L.) R. Br.	-	-	FL	FR	-	-	PR	-	-	-	-	V
132.	*Malva neglecta* Wallr.	-	-	FL	FR	-	-	PR	-	-	-	-	V
133.	*Malva parviflora* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
134.	*Malvastrum coromandelianum* (L.) Garcke	-	-	FL	FR	-	-	PR	-	-	-	-	V
135.	*Matthiola incana* (L.) R. Br.	-	FL	-	FR	-	-	PR	-	-	-	V	-
136.	*Medicago polymorpha* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
137.	*Medicago laciniata* (L.) Mill.	-	-	FL	FR	-	-	PR	-	-	-	-	V
138.	*Medicago minima* (L.) Grufb	-	-	FL	FR	-	-	PR	-	-	-	-	V
139.	*Melilotus indica* (L.) All.	-	-	FL	FR	-	-	PR	-	-	-	-	V
140.	*Melilotus alba* Desr.	-	-	FL	FR	-	-	PR	-	-	-	-	V
141.	*Mentha longifolia* (L.) L.	-	-	-	FL	FR	-	-	PR	-	-	-	V
142.	*Mentha spicata* L.	-	-	-	FL	FR	-	-	PR	-	-	-	V
143.	*Ochthochloa compressa* (Forssk.) Hilu	-	-	FL	FR	-	-	PR	-	-	-	-	V
144.	*Ocimum basilicum* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
145.	*Oligomeris linifolia* (Vahl.) Macbride	-	-	FL	FR	-	-	PR	-	-	-	-	V
146.	*Oryza sativa* L.	-	-	V	-	-	-	FL	FR	-	PR	-	-

147.	*Oxalis corniculata* L.	-	-	V	-	-	-	FL	FR	-	PR	-	-
148.	*Oxystelma esculentum* (L. f.) R. Brown	-	-	V	-	FL	FR	-	-	-	PR	-	-
149.	*Panicum antidotale* Retz.	-	-	-	-	V	-	FL	-	FR	PR	-	-
150.	*Panicum capillare* L.	-	-	FL	FR	-	-	PR	-	-	V	-	-
151.	*Ifloga spicata* (Forssk.) Sch. Bip.	-	-	-	V	-	-	-	FL	FR	-	-	PR
152.	*Portulaca quadrifida* L.	-	V	FL	FR	-	-	PR	-	-	-	-	-
153.	*Peganum harmala* L.	-	V	FL	-	FR	-	PR	-	-	-	-	-
154.	*Phalaris aquatica* L.	-	V	-	FL	FR	-	PR	-	-	-	-	-
155.	*Phragmites karka* (Retz.) Trin. ex Steud.	-	-	-	V	-	-	-	FL	FR	-	-	PR
156.	*Plantago ciliata* subsp. *lanata* (Boiss.) Rech.	-	-	-	-	V	-	FL	-	FR	PR	-	-
157.	*Plantago lanceolata* L.	-	-	V	-	FL	FR	-	-	-	PR	-	-
158.	*Plantago major* L.	-	-	V	-	FL	FR	-	-	-	PR	-	-
159.	*Polypogon monspeliensis* (L.) Desf.	-	V	FL	FR	-	-	PR	-	-	-	-	-
160.	*Poa annua* L.	-	FR	-	-	-	-	PR	-	-	-	V	FL
161.	*Poa infirma* H. B. K.	-	-	V	-	FL	FR	-	-	-	PR	-	-
162.	*Polygonum patulum* M. Bieb.	-	-	-	V	-	-	-	FL	FR	-	-	PR
163.	*Polygonum plebejum* R. Br.	-	FR	-	-	-	-	PR	-	-	-	V	FL
164.	*Psammogeton biternatum* Edgew.	-	V	FL	FR	-	-	PR	-	-	-	-	-
165.	*Pulicaria crispa* (Forssk.) B. H.	-	-	V	-	FL	FR	-	-	-	PR	-	-
166.	*Ranunculus muricatus* L.	-	-	V	-	FL	FR	-	-	-	PR	-	-

167.	*Ranunculus sceleratus* L.	-	-	V	-	FL	FR	-	-	-	PR	-	-
168.	*Ricinus communis* L.	-	-	FL	-	FR	-	PR	-	-	-	V	-
169.	*Reseda odorata* L.	-	FR	-	-	-	-	PR	-	-	-	V	FL
170.	*Rumex dentatus* L.	-	V	FL	FR	-	-	PR	-	-	-	-	-
171.	*Rumex obtusifolius* L.	-	V	FL	FR	-	-	-	-	-	-	-	PR
172.	*Saccharum munja* Roxb.	-	V	FL	FR	-	-	-	-	-	-	-	PR
173.	*Saccharum spontaneum* L.	-	-	-	-	FR	-	-	-	-	PR	V	FL
174.	*Saccharum bengalense* Retz.	-	V	-	FL	-	FR	-	-	-	PR	-	-
175.	*Sclerochloa dura* (L.) P. Beauv.	-	-	V	-	FL	FR	-	-	-	PR	-	-
176.	*Schismus barbatus* (L.) Thell.	-	-	FL	FR	-	-	PR	-	-	-	-	V
177.	*Setaria verticillata* (L.) P. Beauv.	-	FR	-	-	-	-	PR	-	-	-	V	FL
178.	*Silene conoidea* L.	-	-	V	FL	-	FR	-	PR	-	-	-	-
179.	*Sisymbrium irio* L.	-	-	V	FL	-	FR	-	PR	-	-	-	-
180.	*Solanum nigrum* L.	-	-	V	FL	FR	-	-	-	-	PR	-	-
181.	*Solanum surattense* Burm. f.	-	-	-	-	V	FL	-	FR	-	-	-	PR
182.	*Sonchus asper* (L.) Hill	-	-	FL	FR	-	-	PR	-	-	-	-	V
183.	*Sonchus oleraceus* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
184.	*Spergula arvensis* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
185.	*Spergularia marina* (L.) Griseb.	-	-	FL	FR	-	-	PR	-	-	-	-	V
186.	*Taraxacum officinale* F. H. Wigg.	-	-	FL	FR	-	-	PR	-	-	-	-	-

187.	*Torilis japonica* (Houtt.) DC.	-	-	V	FL	FR	-	PR	-	-	-	-	-
188.	*Trianthema portulacastrum* L.	-	-	V	-	FL	FR	-	-	-	PR	-	-
189.	*Tribulus terrestris* L.	-	-	-	-	V	FL	-	FR	-	-	-	PR
190.	*Tribulus pentandrus* Forssk.	-	-	-	-	V	FL	-	FR	-	-	-	PR
191.	*Tricholepis chaetolepis* (Boiss.) Rech. f.	-	-	FL	FR	-	-	PR	-	-	-	-	-
192.	*Trifolium alexandrianum* L.	-	-	-	FL	FR	PR	-	-	-	V	-	-
193.	*Trifolium repens* L.	-	-	-	FL	FR	PR	-	-	-	V	-	-
194.	*Triticum aestivum* L.	-	-	FL	FR	-	PR	-	-	-	-	V	-
195.	*Typha latifolia* L.	-	-	V	-	FL	-	-	FR	-	-	-	PR
196.	*Typha minima* Funck ex Hoppe	--	-	-	V	FL	-	-	FR	-	-	-	PR
197.	*Urtica pilulifera* L.	-	-	FL	FR	-	-	PR	-	-	-	-	-
198.	*Veronica aqutica* Bern.	-	V	FL	FR	-	-	PR	-	-	-	-	-
199.	*Veronica biloba* L.	-	V	FL	FR	-	-	PR	-	-	-	-	-
200.	*Vicia faba* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
201.	*Vicia tetrasperma* (L.) Schreber	-	-	FL	FR	-	-	PR	-	-	-	-	V
202.	*Viola stocksii* Boiss.	-	-	-	-	V	FL	-	FR	-	-	-	PR
203.	*Withania somnifera* (L.) Dunal	V	-	-	FL	-	FR	-	PR	-	-	-	-
204.	*Xanthium strumarium* L.	-	-	FL	FR	-	-	PR	-	-	-	-	V
205.	*Zea mays* L.	-	-	-	-	V	-	FL	FR	-	PR	-	-

Key: V = Vegetative stage; FL = Flowering stage; FR = Fruiting stage and PR = Post Reproductive stage

Table 7. Summary of phenological events (Table 6) of flora of District Tank (all figures are number of species)

S. No	Phenological stage	Months											
		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1	Vegetative (V)	1	22	53	15	23	6	-	1	1	14	21	29
2	Flowering (FL)	-	5	64	29	33	16	25	17	1	1	-	14
3	Fruiting (FR)	1	10	4	62	20	34	6	27	34	6	-	-
4	Post Reproductive (PR)	-	3	1	-	2	6	68	8	-	58	13	46

Table 8. Economic uses classification of Flora of District Tank.

S.No.	Plant species	F	M	Fl	T	Fr	V	C	Th	Ft
	A. Trees									
1.	*Acacia modesta* Wall.	+	-	+	+	-		-	-	-
2.	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	+	+	+	+	-	-	-	-	+
3.	*Dalbergia sissoo* Roxb.	+	-	+	+	-	-	-	-	+
4.	*Eucalyptus globulus* Labill.	-	-	+	+	-	-	-	-	-
5.	*Morus alba* L.	+	-	+	+	+	-	-	-	-
6.	*Morus nigra* L.	+	-	+	+	+	-	-	-	-
7.	*Phoenix dactylifera* L.	+	-	+	+	+	-	-	+	-
8.	*Prosopis farcta* (Banks & Sol.) Macbride.	+	-	+	+	-	-	-	-	-
9.	*Tamarix aphylla* (L.) Karst	+	+	+	+	-	-	-	-	-
10.	*Zizyphus mauritiana* Lam.	+	+	+	+	+	-	-	-	+
	B. Shrubs									
11.	*Abutilon bidentatum* Hochst. ex A. Rich.	-	-	+	-	-	-	-	-	-
12.	*Aerva javanica* (Burm. f.) Juss. ex J. A. Schult.	+	+	+	-	-	-	-	-	-
13.	*Aerva lanata* (L.) Juss. ex Schult.	+	-	-	-	-	-	-	-	-
14.	*Atriplex griffithii* Moq.	+	-	-	-	-	-	-	-	-
15.	*Calligonum polygonoides* L.	+	-	+	-	-	-	-	+	-
16.	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	+	+	+	-	-	-	-	+	-
17.	*Capparis decidua* (Forssk.) Edgew.	+	+	+	+	-	-	-	-	-
18.	*Cassia senna* L.	-	+	+	-	-	-	-	-	-
19.	*Celtis eriocarpa* Decne.	+	-	+	-	+	-	-	-	-
20.	*Crotolaria burhia* Buch.-Ham. ex Benth.	-	-	-	-	-	-	-	-	-
21.	*Dodonaea viscosa* (L.) Jacq.	-	-	+	-	-	-	-	-	-
22.	*Ficus carica* L.	-	+	+	-	+	-	-	-	-

23.	*Haloxylon multiflorum* (Moq.) Bunge ex Boiss.	+	--	+	-	-	-	-	-	-
24.	*Kochia indica* Wight	+	-	-	-	-	-	-	-	-
25.	*Melia azedarach* L.			+					-	-
26.	*Nerium indicum* Mill.	-	-	+	-	-	-	-	-	-
27.	*Parkinsonia aculeata* L.	+	-	-	-	-	-	-	-	-
28.	*Periploca aphylla* Decne.	-	+	-	-	-	-	-	-	-
29.	*Periploca calophylla* (Wight) Falc.	-	+	-	-	-	-	-	-	-
30.	*Prosopis cineraria* (L.) Druce	+	-	+	-	-	-	-	-	-
31.	*Prosopis juliflora* Swartz	+	-	+	-	-	-	-		-
32.	*Rhazya stricta* Decne.	-	+	-	-	-	-	-	-	-
33.	*Salsola foetida* Delile ex Spreng.	+	+	+	-	-	-	-	-	-
34.	*Salvadora oleoides* Decne.	-	+	+	-	-	-	-	-	-
35.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	-	+	+	-	-	-	-	-	-
36.	*Tamarix dioica* Roxb. ex Roth.	-	-	+	-	-	-	-	+	-
37.	*Vitex negundo* L.	-	+	-	-	-	-	-	-	-
38.	*Withania coagulans* (Stocks) Dunal	-	+	-	-	-	-	-	-	-
39.	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	+	-	+	-	+	-	-	-	-
	C. Herbs									
40.	*Achyranthes aspera* L.	-	+	-	-	-	-	-	-	-
41.	*Alhagi maurorum* Medic.	-	+	+	-	-	-	-	+	-
42.	*Allium cepa* L.	-	+	-	-	-	-	+	-	-
43.	*Allium sativum* L.	-	+	-	-	-	+	+	-	-
44.	*Amaranthus graecizans* L.	+	-	-	-	-	+	-	-	-
45.	*Amaranthus spinosus* L.	+	-	-	-	-	+	-	-	-
46.	*Amaranthus viridis* L.	+	+	-	-	-	+	-	-	-
47.	*Anagallis arvensis* L.	-	+	-	-	-	-	-	-	-
48.	*Anethum graveolens* L.	+	-	-	-	-	-	-	-	-

49.	*Aristida adscensionis* L.	+	-	-	-	-	-	-	-	-
50.	*Aristida cyanantha* Nees ex Steud.	+	-	-	-	-	-	-	-	-
51.	*Aristida mutabilis* Trin. & Rupr.	+	-	-	-	-	-	-	-	-
52.	*Aristida triticoides* Henr.	+	-	-	-	-	-	-	-	-
53.	*Arnebia hispidissima* (Lehm.) A. DC.	-	-	-	-	-	-	-	-	-
54.	*Arnebia guttata* Bunge	-	-	-	-	-	-	-	-	-
55.	*Asphodelus tenuifolius* Cav.	+	+	-	-	-	-	-	-	-
56.	*Astragalus tribuloides* Delile	+	-	-	-	-	-	-	-	-
57.	*Astragalus amherstianus* Royle ex Benth.	+	-	-	-	-	-	-	-	-
58.	*Avena sativa* L.	+	-	-	-	-	-	-	-	-
59.	*Boerhavia diffusa* L.	+	-	-	-	-	-	-	-	-
60.	*Boerhavia procumbens* Banks ex Roxb.	+	-	-	-	-	-	-	-	-
61.	*Brassica rapa* subsp. *campestris* (L.) Clapham	+	-	+	-	-	-	-	+	-
62.	*Campanula benthamii* Wall. ex Kitamura	+	-	-	-	-	-	-	-	-
63.	*Campanula sulaimanii* E. Nasir	+	-	-	-	-	-	-	-	-
64.	*Cenchrus biflorus* Roxb.	+	-	-	-	-	-	-	-	-
65.	*Cenchrus ciliaris* L.	+	-	-	-	-	-	-	-	-
66.	*Centaurea iberica* Trevir. ex Spreng.	+	-	-	-	-	-	-	-	-
67.	*Centaurea moschata* L.	-	-	-	-	-	-	-	-	-
68.	*Centaurium pulchellum* (Sw.) Druce	+	-	-	-	-	-	-	-	-
69.	*Centaurium spicatum* (L.) Fritsch	-	-	-	-	-	-	-	-	-
70.	*Chenopodium album* L.	+	+	-	-	-	-	-	-	-
71.	*Chenopodium ambrosioides* L.	+	-	-	-	-	-	-	-	-
72.	*Chenopodium murale* L.	-	+	-	-	-	-	-	-	-

73.	*Chenopodium nepalense* Colla	+	-	-	-	-	-	-	-	-
74.	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	-	-	-	-	-	-	-	-	-
75.	*Chrozophora tinctoria* (L.) Raf.	-	-	-	-	-	-	-	-	-
76.	*Cicer arietinum* L.	+	-	-	-	-	-	+	-	-
77.	*Citrullus colocynthis* (L.) Schrad.	+	+	-	-	-	-	-	-	-
78.	*Cleome brachycarpa* Vahl ex DC.	-	-	-	-	-	-	-	-	-
79.	*Convolvulus prostratus* Forssk.	+	-	-	-	-	-	-	-	-
80.	*Convolvulus arvensis* L.	+	+	-	-	-	-	-	-	-
81.	*Convolvulus microphyllus* Sieb.ex Spreng.	+	-	-	-	-	-	-	-	-
82.	*Conyza canadensis* (L.) Cronquist	+	-	-	-	-	-	-	-	-
83.	*Corchorus aestuans* L.	-	-	-	-	-	-	-	-	-
84.	*Coronopus didymus* (L.) Smith	+	-	-	-	-	-	-	-	-
85.	*Cousinia minuta* Boiss.	-	-	-	-	-	-	-	-	-
86.	*Crambe cordifolia* Steven	+	-	-	-	-	-	-	-	-
87.	*Cuscuta reflexa* Roxb.	-	-	-	-	-	-	-	-	
88.	*Cyamopsis tetragonoloba* (L.) Taubert	+	-	-	-	-	-	-	-	-
89.	*Cymbopogon jwarancusa* (Jones) Schult.	+	+	+	-	-	-	-	+	-
90.	*Cynodon dactylon* (L.) Pers.	+	-	-	-	-	-	-	-	-
91.	*Cynoglossum lanceolatum* Forssk.	+	-	-	-	-	-	-	-	-
92.	*Cyprus difformis* L.	-	-	-	-	-	-	-	-	-
93.	*Cyprus rotundus* L.	-	-	-	-	-	-	-	-	-
94.	*Dactyloctenium aegyptium* (L.) Willd.	+	+	-	-	-	-	-	-	-
95.	*Datura alba* Nees	-	-	-	-	-	-	-	-	-

96.	*Desmostachya bipinnata* (L.) Stapf.	+	-	-	-	-		-	-	-
97.	*Dichanthium annulatum* (Forssk.) Stapf.	+	-	-	-	-	-	-	-	-
98.	*Echinochloa colona* (L.) Link.	+	-	-	-	-	-	-	-	-
99.	*Echinochloa crus-galli* (L.) Beauv.	+	-	-	-	-	-	-	-	-
100.	*Eclipta alba* (L.) Hassk.	+	-	-	-	-	-	-	-	-
101.	*Emex australis* Steinh.	-	-	-	-	-	-	-	-	-
102.	*Emex spinosus* (L.) Campd.	-	-	-	-	-	-	-	-	-
103.	*Equisetum arvense* L.	-	+	-	-	-	-	-	-	-
104.	*Eragrostis cilianensis* (All.) Lut. ex F.T.	+	-	-	-	-	-	-	-	-
105.	*Eragrostis minor* Host	+	-	-	-	-	-	-	-	-
106.	*Euphorbia dracunculoides* Lam.	-	-	-	-	-	-	-	-	-
107.	*Euphorbia granulata* Forssk.	-	-	-	-	-	-	-	-	-
108.	*Euphorbia helioscopia* L.	-	+	-	-	-	-	-	-	-
109.	*Euphorbia prostrata* Ait.	+	-	-	-	-	-	-	-	-
110.	*Euphorbia thymefolia* L.	-	-	-	-	-	-	-	-	-
111.	*Fagonia indica* var. *schweinfurthii* Hadidi	+	+	-	-	-	-	-	-	-
112.	*Farsetia hamiltonii* Royle	+	-	-	-	-	-	-	-	-
113.	*Farsetia ramosissima* Hochst. ex Boiss.	+	-	-	-	-	-	-	-	-
114.	*Filago arenaria* (Smoljan.) Chrtek & Holub	+	-	-	-	-	-	-	-	-
115.	*Fumaria indica* (Hausskn.) Pugsley	+	-	-	-	-	-	-	-	-
116.	*Gastrocotyle hispida* (Forssk.) Bunge	+	-	-	-	-	-	-	-	-
117.	*Halostachys belangerana* (Moq.) Botsch.	+	-	-	-	-	-	-	-	-
118.	*Heliotropium elipticum* Ledeb.	+	-	-	-	-	-	-	-	-
119.	*Heliotropium europaeum* L.	+		-	-	-	-	-	-	-

120.	*Heliotropium ovalifolium* Forssk.	+	-	-	-	-	-	-	-	-
121.	*Hyoscyamus squarrosus* Griffith	-	-	-	-	-	-	-	-	-
122.	*Hypecoum pendulum* L.	+	-	-	-	-	-	-	-	-
123.	*Hypericum perforatum* L.	+	-	-	-	-	-	-	-	-
124.	*Imperata cylindrica* L.	+	-	-	-	-	-	-	-	-
125.	*Juncus bufonius* L.	-	-	-	-	-	-	-	+	-
126.	*Juncus inflexus* L.	-	-	-	-	-	-	-	+	-
127.	*Lathyrus aphaca* L.	+	-	-	-	-	-	-	-	-
128.	*Lathyrus sativus* L.	+	-	-	-	-	-	-	-	-
129.	*Launaea nudicaulis* (L.) Hook. f.	+	-	-	-	-	-	-	-	-
130.	*Malcolmia africana* (L.) R. Br.	+	-	-	-	-	-	-	-	-
131.	*Malcolmia scorpioides* (Bunge) Boiss.	+	-	-	-	-	+	-	-	-
132.	*Malva neglecta* Wallr.	+	-	-	-	-	+	-	-	-
133.	*Malva parviflora* L.	+	+	-	-	-	+	-	-	-
134.	*Malvastrum coromandelianum* (L.) Garcke	+	+	-	-	-	-	-	-	-
135.	*Matthiola incana* (L.) R. Br.	+	-	-	-	-	-	-	-	-
136.	*Medicago minima* (L.) Grufb	+	-	-	-	-	-	-	-	-
137.	*Medicago polymorpha* L.	+	+	-	-	-	-	-	-	-
138.	*Medicago laciniata* (L.) Mill.	+	-	-	-	-	-	-	-	-
139.	*Melilotus indica* (L.) All.	+	-	-	-	-	-	-	-	-
140.	*Melilotus alba* Desr.	+	+	-	-	-	-	-	-	-
141.	*Mentha longifolia* (L.) L.	-	+	-	-	-	-	-	-	-
142.	*Mentha spicata* L.	-	+	-	-	-	-	+	-	-
143.	*Ochthochloa compressa* (Forssk.) Hilu	+	-	-	-	-	-	-	-	-
144.	*Ocimum basilicum* L.	-	+	-	-	-	-	+	-	-
145.	*Oligomeris linifolia* (Vahl.) Macbride	-	-	-	-	-	-	-	-	-
146.	*Oryza sativa* L.	+							-	-

147.	*Oxalis corniculata* L.	+	-	-	-	-	-	-	-	-
148.	*Oxystelma esculentum* (L. f.) R. Brown	+	-	-	-	-	-	-	-	-
149.	*Panicum antidotale* Retz.	+	-	-	-	-	-	-	-	-
150.	*Panicum capillare* L.	+	-	-	-	-	-	-	-	-
151.	*Ifloga spicata* (Forssk.) Sch. Bip.	+	-	-	-	-	-	-	-	-
152.	*Peganum harmala* L.	-	-	-	-	-	-	-	-	-
153.	*Phalaris aquatica* L.	+	+	-	-	-	-	-	-	-
154.	*Phragmites karka* (Retz.) Trin. ex Steud.	-	-	-	-	-	-	-	+	-
155.	*Plantago ciliata* subsp. *lanata* (Boiss.) Rech.	+	-	-	-	-	-	-	-	-
156.	*Plantago lanceolata* L.	+	+	-	-	-	-	-	-	-
157.	*Plantago major* L.	+	+	-	-	-	-	-	-	-
158.	*Poa annua* L.	+	-	-	-	-	-	--	-	-
159.	*Poa infirma* H. B. K.	+	-	-	-	-	-	-	-	-
160.	*Polygonum patulum* M. Bieb.	-	-	-	-	-	-	-	-	-
161.	*Polygonum plebejum* R. Br.	-	-	-	-	-	-	-	-	-
162.	*Polypogon monspeliensis* (L.) Desf.	+	-	-	-	-	-	-	-	-
163.	*Portulaca quadrifida* L.	+	-	-	-	-	-	-	-	-
164.	*Psammogeton biternatum* Edgew.	-	-	-	-	-	-	-	-	-
165.	*Pulicaria crispa* (Forssk.) B.H.	-	-	-	-	-	-	-	-	-
166.	*Ranunculus muricatus* L.	+	-	-	-	-	-	-	-	-
167.	*Ranunculus sceleratus* L.	+	-	-	-	-	-	-	-	-
168.	*Reseda oderata* L.	+	-	-	-	-	-	-	-	-
169.	*Ricinus communis* L.	-	-	+	-	-	-	-	-	-
170.	*Rumex dentatus* L.	+	+	-	-	-	+	-	-	-
171.	*Rumex obtisifolius* L.	+	-	-	-	-	-	-	-	-
172.	*Saccharum bengalense* Retz.	+	-	-	-	-	-	-	-	-
173.	*Saccharum munja* Roxb.	+	-	-	-	-	-	-	-	-

174.	*Saccharum spontaneum* L.	+	-	-	-	-	-	-	-	-
175.	*Schismus barbatus* (L.) Thell.	+	-	-	-	-	-	-	-	-
176.	*Sclerochloa dura* (L.) P. Beauv.	+	-	-	-	-	-	-	-	-
177.	*Setaria verticillata* (L.) P. Beauv.	+	-	-	-	-	-	-	-	-
178.	*Silene conoidea* L.	-	-	-	-	-	-	-	-	-
179.	*Sisymbrium irio* L.	+	-	-	-	-	-	-	-	-
180.	*Solanum nigrum* L.	+	-	-	-	-	-	-	-	-
181.	*Solanum surattense* Burm. f.	+	+	-	-	-	-	-	-	-
182.	*Sonchus asper* (L.) Hill	+	-	-	-	-	-	-	-	-
183.	*Sonchus oleraceus* L.	+	-	-	-	-	-	-	-	-
184.	*Spergula arvensis* L.	+	-	-	-	-	-	-	-	-
185.	*Spergularia marina* (L.) Griseb.	+	-	-	-	-	-	-	-	-
186.	*Taraxacum officinale* F. H. Wigg.	+	-	-	-	-	-	-	-	-
187.	*Torilis japonica* (Houtt.) DC.	+	-	-	-	-	-	-	-	-
188.	*Trianthema portulacastrum* L.	+	-	-	-	-	-	-	-	-
189.	*Tribulus terrestris* L.	+	+	-	-	-	-	-	-	-
190.	*Tribulus pentandrus* Forssk.	+	-	-	-	-	-	-	-	-
191.	*Tricholepis chaetolepis* (Boiss.) Rech. f.	+	-	-	-	-	-	-	-	-
192.	*Trifolium alexandrianum* L.	+	-	-	-	-	-	-	-	-
193.	*Trifolium repens* L.	+	-	-	-	-	-	-	-	-
194.	*Triticum aestivum* L.	+							-	-
195.	*Typha latifolia* L.	-	-	+	-	-	-	-	+	-
196.	*Typha minima* Funck ex Hoppe	-	-	-	-	-	-	-	+	-
197.	*Urtica pilulifera* L.	+	-	-	-	-	+	-	-	-
198.	*Veronica aquatica* Bern.	-	-	-	-	-	-	-	-	-
199.	*Veronica biloba* L.	-	-	-	-	-	-	-	-	-
200.	*Vicia faba* L.	+	-	-	-	-	-	-	-	-

201.	*Vicia tetrasperma* (L.) Schreber	+	-	-	-	-	-	-	-	-
202.	*Viola stocksii* Boiss.	+	-	-	-	-	-	-	-	-
203.	*Withania somnifera* (L.) Dunal	-	+	+	-	-	-	-	-	-
204.	*Xanthium straumarium* L.	-	-	+	-	-	-	-	-	-
205.	*Zea mays* L.	+	-	-	-	-	-	-	-	-
Total		142	46	36	11	7	9	5	12	3
% age		69.2	22.4	17.5	5.3	3.4	4.3	2.4	5.8	1.4

Key: F = Fodder; M = Medicinal; Fl =Fuel; T = Timber; Fr = Fruit; V = Vegetable; C = Condiment; Th = Thatching; Ft = Furniture.

VEGETATION STRUCTURE

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Phytosociology

During quantitative analysis of vegetation 138 species of 34 families were listed throughout the year (Table 9). There were 61, 50, 77 and 58 species respectively in autumn, winter, spring and summer season in the investigated area (Table 10). There were 28, 25, 33 and 30 families respectively in autumn, winter, spring and summer. The floristic showed 67.7% similarity between autumn and winter, 65.7% between autumn and spring and 65.6 between autumn and summer. Similarly, 52.7%, similarity between winter and spring and 66.6% similarity between winter and summer was noticed. The highest similarity of 73.5% was found between spring and summer flora (Table 11).

Community structure

The vegetation, climate and soil are intricately related to each other. The variation in any one of these components might cause a change in the other associated components. By knowing two of the factors, prediction about the third might be possible within certain limits. The existence and establishment of community reflects the plant type and habitat condition under which they develop. Biotic factors, especially human interaction shape the course of succession of a community or vegetation type (Grubb, 1987; Badshah *et al*., 2010a). A community is defined as an aggregate of living plants having mutual relations among themselves and to the environment, or a collection of plant population found in one habitat type in one area and integrated to a degree by a competition complementarities and dependence (Hussain & Badshah, 1998; Ahmad *et al*., 2006).

Some of the major environmental factors that influence the vegetation and parts thereof are deforestation, overgrazing, trampling, erosion and other ecological factors. The investigated area is almost flat plains with a semiarid climate. The present study recognizes different plant communities based on quantitative values which as whole link up the major vegetation type/unit. The present study concludes that there could possibly be 24 different plant communities during four seasons in the area. The observed changes in the plant communities are due to season, temperature, soil type and time of sampling of the vegetation. During spring and summer many annual exhibited dominance and caused change in the seasonal aspect. They approach each other by sharing the species and that is why 73.5% similarity occurred. The woody and perennial herbaceous species

almost remained the same, however, slight changes in their cover existed with season to season but the predominance of annuals changed the community composition. The recorded species exhibit different dominance value due to change in habitat condition throughout the area

A. Autumn aspect

Considering the floristic, the well represented families in terms of number of species were Poaceae (10 sp.) and Mimosaceae and Chenopodiaceae (5 sp. each). Each of the families Amaranthaceae, Asclepiadaceae, Euphorbiaceae and Polygonaceae had 3 species. While considering the family importance value (FIV), it was seen that Mimosaceae with 5 species was leading with FIV of 309.9, followed by Poaceae (10 sp., FIV= 233.2), Chenopodiaceae (5 sp., FIV=118.2), Tamaricaceae (2 sp., FIV= 117.1), Asclepiadaceae (3sp. FIV= 99.8), Typhaceae (2 sp., FIV= 86.9), Amaranthaceae (3 sp., FIV= 86.2), Salvadoraceae (1 sp., FIV= 78.9) and Polygonaceae (3 sp., FIV= 74.7). The remaining families were lower both in terms of number of species and FIV (Table 10). There were six plant communities with the following structure during autumn.

1. *Typha-Tamarix-Tamarix* community (TTT)

Typha-Tamarix aphylla-Tamarix dioica community was present at water-logged habitats (Table 12, Appendix 1). Of the 18 recorded species, there were 3 trees, 5 shrubs, 6 herbs and 4 grasses. The total importance value (TIV) contributed by 3 dominants was 126.3, while TIV of 173.2 was shared by the remaining species. The contribution by tree species was 78.2, by shrubs 66.7, by herbs 94.2 and grasses 60.4. *Phoenix dactylifera*, *Prosopis cineraria* and *Phragmites karka* were sub dominants. *Imperata cylindrica* and *Euphorbia thymifolia* etc. were associated species. Luis *et al*. (2002) reported similar condition in the water-logged habitats. This community possessed the second largest species diversity as most of the plants of this community were none to slightly palatable. These findings agree with Hadi *et al*. (2009) who reported *Tamarix* and *Capparis* community from Peshawar. Similarly, Ahmad *et al*. (2009d) reported ten *Olea* communities from Dir Khyber Pakhtunkhwa, which are in agreement with the present results.

The vegetation was predominantly geophytic (27.8%), followed by therophytes (22.2%). Nanophanerophyte, chamaephytes and microphanerophytes each had 16.7%

share. The leaf spectra consisted of leptophylls (50.0%), nanonphylls (33.3%) and mesophylls (16.7%) (Table 13). Our findings are in line with those of Malik & Malik (2004), Malik & Hussain (2006), Tripathi (2007) and Guo *et al*. (2009).

2. *Desmostachya-Chenopodium-Acacia* community (DCA)

Desmostachya-Chenopodium-Acacia community occupied near cultivated lands. There were 13 species having 4 tree, 4 shrub, 4 herb and 1 grass species. The TIV contributed by three dominants was 174.1 and the remaining species shared a TIV of 125.6. The TIV contribution by trees was 95.7, by shrubs 41.2, by herbs 97.5 and by grasses 65.7 (Table 12, Appendix 2). *Tamarix aphylla* and *Prosopis farcta* were the co-dominants. *Convolvulus arvensis* and *Zizyphus mauritiana* were associated species. The change of dominance from *Typha* to *Desmostachya* as seen in this community might be due to scarcity of water and eradication of most of the plants to clear lands for cultivation. Generally the cultivated land possesses low wild plants due to anthropogenic interference (Devineau & Fournier, 2007; Frances & Shahroukh, 2006). Same is true in the present study.

The major life form was microphanerophytic (30.7%) that was followed by therophytes (23.1%). Each of the nanophanerophytes, chamaephytes and hemicryptophytes had 15.3% contribution. The leaf spectrum was lepto-nanophyllous (Table 13) consisting of leptophyll (46.1%) and nanophyll (53.8%) only. Microphanerophytic life form indicates mesophytic condition. In the present situation microphanerophyte and leptonanphllous shows slight diversion to mesophytic condition. Similar report was also made by Malik & Malik (2004), Ahmad *et al*. (2006), Perveen & Hussain (2007) and Badshah *et al*. (2010a).

3. *Saccharum-Citrullus-Tribulus* community (SCT)

This community was recognized in sandy habitats with 16 species (Table 12, Appendix 3) including 2 trees, 5 shrubs, 5 herbs and 4 grasses. Three dominants and the remaining species had TIV of 131.7 and 167.5, respectively. Herbs with a TIV of 110.2 were the major contributors. The contribution by shrubs was 81.4, by grasses 74.3 and by trees 34.3. Dasti *et al*. (2010) while working on the vegetation of Suleiman ranges reported *Calotropis* and *Capparis decidua* as dominant plant however, in the present case *Calotropis procera, Prosopis cineraria, Capparis decidua* and *Salvadora oleoides* etc

were as associated species. This habitat differed from others. Similar findings were reported by Arshad *et al*. (2008) and Arshad & Akbar (2002).

Hemicryptophytes dominated with a share of 31.1%. They were followed by nanophanerophyte (25.0%), therophyte (18.7%), chamaephyte and microphanerophyte each group contributing 12.5%. The leaf spectra were composed of leptophylls (43.7%), nanophylls (25.0%), microphylls and aphyllous species (each with 12.5%) and mesophylls (6.2%) species (Table 13). Due to dryness of water, prevailing high temperature and poor soil texture, xerophytic herbs and shrubs dominated. Similar trend was reported by Arshad (2003) and Malik & Hussain (2006) from other areas of Pakistan. Similarly, Shukla & Mishra (2006) stated that highest therophytes occurrence followed by chamaephytes. This finding favors the present results.

4. *Salvadora-Periploca-Withania* community (SPW)

At foothills, *Salvadora-Periploca-Withania* community consisted of 2 tree, 12 shrub, 2 herb and 1 grass species. A TIV of 141.6 and 158.1 was recorded for dominants and other species, respectively (Table 12, Appendix 4). Tree species contributed a TIV of 30.0, shrubs 233.8, herbs 26.4 and grasses 9.7. Heavy overgrazing and deforestation has changed the physiognomy of the vegetation into scrub community. These findings are in line with those of Peer *et al*. (2007), Perveen & Husain (2007) and Ahmad *et al*. (2008b) who stated that grazing affects community structure.

Nanophanerophytes (47.0%) were dominant, followed by chamaephytes (23.5%), microphanerophytes (17.6%) and therophytes (11.8%). Due to high temperature and Sandy loam soil undershrubs were dominant vegetation. This agrees with other workers (Hussain *et al*., 2005; Malik & Hussain, 2008; Hussain *et al*., 2009). The leaf spectrum was composed of leptophylls (41.2%), nanophylls and aphyllous species each with 17.6%. Mesophylls (11.8%) and microphylls (1.8%) were next leaf size classes (Table 13). This community had 17.6% aphyllous species indicating desert conditions. This in accordance with those of Arshad *et al*. (2008), Hussain *et al*. (2005) and Badshah *et al*. (2010a) who reported the predominance of small leaved species due to aridity.

5. *Aerva-Rumex-Typha* community (ART)

Along water courses, *Aerva-Rumex-Typha* community was recognized. It consisted of 2 tree, 5 shrub, 7 herb and 1 grass species. The TIV contributed by three

dominants was 136.8, and by the remaining species it was 163.2. The contribution by herbs was 152.3, by shrubs 105.9, by trees 30.6 and that by grasses 11.5. *Prosopis cineraria, P. juliflora, Tamarix aphylla* and *Eclipta alba* were subdominants (Table 12, Appendix 5). This community flourishes the water courses during floods and rainy seasons which facilitates the growth of sedges. A similar situation has been reported by earlier workers in their studies (**Enright *et al.*, 2005; Badshah *et al.*, 2010a; Claros, 2003).**

Geophytes were dominant (26.9%), which were followed by therophytes and chamaephytes (each with 20%). Nanophanerophytes and microphanerophytes each had 13.3% contribution and hemicryptophytes were 6.7%. The leaf spectra consisted of leptophylls (46.7%), nanophylls (33.3%), mesophylls (13.3%) and microphylls (6.7%) (Table 13). Here too geophytes and annual dominated according to sufficient availability of water. The aquatic plants are geophytes and with small leaves as stated by Mark *et al.* (2001), Malik & Hussain (2006), Sher & Khan (2007) and Bocuk *et al.* (2009).

6. *Prosopis cineraria-Capparis-Prosopis farcta* community (PCP)

On dry range lands *Prosopis cineraria-Capparis-Prosopis farcta* community was recorded (Table 12, Appendix 6). There were one tree, 6 shrub, 3 herb and 3 grass species. TIV by three dominants was 157.9 and by others species 141.7. The major contributors were shrubs with 211.6. The TIV of grasses, herbs and trees was respectively 38.8, 31.4 and 17.9. Dryland was poor in species due to unfavorable environmental soil and air condition. They habitat had xerophytic trees and undershrubs. These results are in line with that of Arshad & Akbar (2002) and Arshad *et al.* (2008) who reported that Cholistan desert had poor species richness.

Nanophanerophytic and hemicryptophytic (each with 30.1%) were dominant life forms followed by chamaephytes (23.1%). Therophytes, geophytes and microphanerophytes all shared an equal value of 7.7%. Similarly, the leaf spectra were composed by leptophyll (53.8%), nanophyll and microphyll (each 15.4%) and mesophyll and aphyllous (each with 7.7%) (Table 13). The biological spectrum and leaf size is the indicator of soils, climate and biotic adversities. In these areas, heavy destruction has changed phanerophytic vegetation to hemicryptophytes and therophytes. Therophytes are

more prevalent in summer and spring than other life forms. These findings are in line with other workers (Bocuk *et al*., 2009; Ture & Tokur, 2000; Wahab *et al*., 2008).

B. Winter aspect

Winter aspect had six plant communities with a total of 50 species distributed among 25 families. The most important family in terms of number of species was Poaceae (10 sp.) and Mimosaceae (5 sp.). Chenopodiaceae and Polygonaceae, respectively had 4 and 3 species. The remaining families possessed either 2 or less than 2 species.

However, when FIV was considered the reverse was true as Mimosaceae had FIV of 301.7, Poaceae had 175.6, Asclepiadaceae (2 sp., FIV= 141.3), Capparidaceae (1 sp., FIV= 101.5), Chenopodiaceae (4 sp., FIV= 97.4), Cyperaceae (2 sp. FIV= 75.9) and Salvadoraceae (1 sp., FIV= 76.5). The remaining families were less in terms of FIV and number of species (Table 10). The detail of communities is as follows:

1. *Tamarix dioica-Phoenix-Tamarix aphylla* community (TPT)

Tamarix dioica-Phoenix-Tamarix aphylla community consisted of 12 species in saline habitat. It included 5 shrub, 3 tree and 3 herb and 1 grass species. The three dominants provided a TIV of 173.4 and 125.8, by remaining species (Table 12, Appendix 7). The contribution by tree species was 109.2, by shrubs 120.1, by herbs 53.2 and by grasses 16.7. *Typha latifolia*, *Cyprus rotundus* and *Suaeda fruticosa* were co-dominants. The associated species were *Aristida mutabilis*, *Salsola foetida*, *Prosopis cineraria*, *Acacia nilotica ssp. nilotica* and *Eclipta alba*. During winter the *Typha* was replaced by *Phoenix* as *Typha* was harvested and the sub dominant *Phoenix* joined the community. Similar dynamics of the community was also reported by Tabanez & Viana (2000), Malik & Malik (2004) and Ahmad *et al*. (2007).

Nanophanerophytes, geophytes and microphanerophytes each with 25.0% dominated the site. They were followed by chamaephytes (16.6%) and therophytes (8.3%). The leaf size spectra consisted leptophylls (50.0%), nanophylls (33.3%) and mesophylls (16.6%) (Table 13). This community comparatively possessed trees therefore dominated by nano-microphanerophytes. Similarly, Hussain & Perveen (2009), Bocuk *et al*. (2009) and Perveen *et al*. (2008) reported nanophanerophytic and microphanerophytic plants communities in their respective areas which agree with the present work.

2. *Convolvulus -Chenopodium-Dichanthium* community (CCD)

This community, recorded near cultivated lands (Table 12, Appendix 8), consisted of 4 tree and 4 shrub, 8 herb and 3 grass species. The dominants and the remaining species had a TIV of 125.1 and 174.8, respectively. The major share of 134.5 was provided by herbs. Trees, shrubs and grasses contributed 60.5, 40.2 and 64.8, respectively. This community is depends on moisture left after irrigation of their farms and was to winter. The result is similar to earlier workers (Kareston *et al*., 2005; Costa *et al*., 2006; Parveen & Hussain, 2007; Ahmad *et al*., 2008a) who reached to the similar conclusions in their study.

Therophytic species were dominant (36.8%). It was followed by microphanerophytes (21.1%). Chamaephytes, geophytes and hemicryptophytes each had 10.5% contribution. Nanophylls and leptophylls respectively had 52.6% and 42.1% share followed by 5.3% share by microphylls (Table 13). The dominance of therophytes was also reported by Costa *et al*. (2007), Sher & Khan (2007) and Hussain & Perveen (2009) in similar climatic conditions which strengthen our findings.

3. *Asphodelus-Gastrocotyle-Hypericum* community (AGH)

At dry sandy habitats, the community consisted of 2 tree, 5 shrub, 5 herb and 2 grass species. TIV by three dominants was 137.7 and 161.8 by the remaining species (Table 12, Appendix 9). TIV contribution by herbs was 162, by shrubs 63.9, by trees 51.4 and by grasses 21.9. The sub-dominants were *Prosopis farcta*, *Acacia nilotica ssp. nilotica* and *Periploca calophylla*, while *Capparis decidua*, *Saccharum spontaneum*, *Echinochloa colona* and *Emex australis* associated the community. Similarly, Dasti & Malik (2000) and Malik *et al*. (2000) reported some of these plants from Indus valley slopes and waste lands respectively. They also reported that *Asphodelus* was the characteristic species of sandy habitats during winter and this agree with our findings.

Nanophanerophytes (28.6%), therophytes and chamaephytes (each with 21.4%) dominated the habitat. Microphanerophytes (14.3%), geophytes and hemicryptophytes (7.1% each) were next important group. The dominant leaf size was leptophyllous (35.7%), followed respectively by nanophylls (28.6%), microphylls and aphyllous

species (each with 14.3%). Mesophylls were 7.1% of the total (Table 13). Nano-therophytic life form indicated that due to sandy condition where soil has poor moisture therefore therophyte and xerophytic shrubs are prevailing. This view is also supported by Manhas *et al*. (2010) who recorded similar life form and leaf spectra in desert condition. The leptophyllous dominancy show drought condition in the investigated area also supported by various workers (Nazir & Malik, 2006; Badshah *et al*., 2010a) who reported lepto - nanophyllous communities respectively from Azad Kashmir and South Waziristan. These findings further supported our findings.

4. *Salvadora-Periploca-Withania* community (SPW)

Salvadora-Periploca-Withania community harboring foothills had 12 shrub and 2 tree species. Herbs and grasses were absent in this community (Table 12, Appendix 10). The TIV shared by 3 dominants was 161.8 while the remaining species had 137.3 TIV. The contribution by shrubs alone was 265.2 and by trees were 33.5. *Acacia modesta* and *A. nilotica ssp. nilotica* was sub-dominants. *Calotropis procera*, *Aerva javanica* and *Zizyphus nummularia* were also present in this community. This community was observed under heavy browsing and deforestation which changed the *Salvadora* community into scrub vegetation. Salvatori *et al*. (2003) while studying the vegetation observed that 46% of the area was converted from wood land to scrub and grassland. These finding are in line to the extent that have similar results (Patrick *et al*., 2004; Walepole *et al*., 2004; Jorge *et al*., 2005) in the area of investigation.

Phanerophytic species were dominant (57.1%), followed by chamaephytes and microphanerophytes (each with 21.4%). The leaf size was predominantly leptophyllous (35.7%), followed by nanophylls and aphyllous (each with 21.4%), mesophyll (14.3%) and microphylls (7.1%) species (Table 13). The life form and leaf size spectra are important physiognomic attributes that have been widely used in vegetation studies. The life form spectra are said to be the indicators of micro and macroclimate. Mark *et al*. (2001) and Batalha & Martins (2004) recorded 75 phanerophytes in Cerrado site, which are in line with our findings.

5. *Suaeda-Cyprus-Prosopis* community (SCP)

During winter, dry water courses had *Suaeda-Cyprus-Prosopis* community with 10 species including 2 tree, 5 shrub, 2 herbs and 1 grass (Table 12, Appendix 11). The

TIV contributed by 3 dominants was 159.2 and 140.5 by the remaining species. Tree species provided 33.2, shrubs 169.9, herbs 78.9 and grasses 17.6. The co-dominants were *Prosopis juliflora, Abutilon bidentatum* and *Aerva javanica. Acacia nilotica, Tamarix aphylla, Typha latifolia* and *Poa annua* were the associated flora in this site. This habitat which exhibited *Aerva-Rumex- Typha* previously during autumn now inhibited by *Suaeda- Cyprus-Prosopis* which indicated the community dynamic and life cycle of plants. This view is also supported by other researchers (Badshah *et al*., 2010a; Mosugelo *et al*., 2002; Malik & Husain, 2006).

Chamaephytes (30.0%) were dominance, which were followed by nanophanerophytes, geophytes and mircophanerophytes (each with 20.0%). There were 70.0% leptophylls, 20.0% nanophylls and 10.0% mesophylls (Table 13). Hussain & Perveen (2009) also stated that chamaephytes were the dominant life form and leptophyll as leaf size spectrum under dry desert condition. This is in accordance with the present work as our area is arid to semiarid.

6. *Capparis-Calotropis-Prosopis* community (CCP)

Capparis-Calotropis-Prosopis community was established on dry range lands. It had 11 species (Table 12, Appendix 12) including 1 tree, 6 shrub and 4 grass species. The TIV contributed by 3 dominants and remaining species was 167.8 and 131.9, respectively. Trees gathered a TIV of 20.7, shrubs 222.2 and grasses 56.8. The sub-dominants were *Acacia nilotica, Salsola foetida, Suaeda fruticosa* while *Cenchrus ciliaris, Prosopis farcta* and *Poa annua* were associated species. *Calotropis* and *Prosopis* possessed high IV due to their non-palatability while *Capparis* was spiny. Non palatable species generally have high density, cover and growth. Similar observation was made by Arshad *et al*. (2008); Malik & Hussain (2008) and Husain & Perveen, (2009). Hussain & Chughtai (1984) stated that non-palatable species increased in Hazarganji rangelands due to overgrazing.

Nanophanerophytes, chamaephytes and hemicryptophytes (each with 27.2%) were the dominant life forms. Leaf spectra had maximum leptophylls (72.7%) followed by nanophyll, mesophyll and aphyllous (each with 9.1%) (Table 13). Small tree, shrubs and perennial herbs were the major life form due to lack of moisture and rainfall. Al-Yemeni & Sher (2010) stated that in Asir Mountain, xeric condition exhibited

nanophanerophytes and chamaephytes as dominant vegetation, which strengthen our findings due to climatic similarity.

C. Spring aspect

Spring aspect had 6 plant communities with a total of 72 species among 33 families. Based on the number of species, Poaceae (9 sp.) was leading. It was followed by Asteraceae (6 sp.), Papilionaceae, Mimosaceae and Polygonaceae (each with 5 sp.). The remaining families had fewer species. Whereas, FIV indicated that Mimosaceae (240.3), Chenopodiaceae (173.5), Tamaricaceae (118) and Asteraceae (109.9) were leading in the area (Table 10). The detail of communities is given below:

1. *Tamarix-Suaeda-Typha* community (TST)

The saline habitats had *Tamarix-Suaeda-Typha* community with 20 species, which included 8 herbs, 5 shrubs, 4 grasses and 3 trees (Table 12, Appendix 13). The TIV of 3 dominants and a remaining species was 139.0 and 160.7, respectively. Shrubs, herbs, trees and grasses contributed 127.6, 73.3, 68.7 and 30.1, respectively. *Phoenix dactylifera* and *Tamarix aphylla* were sub-dominants. *Prosopis cineraria*, *Suaeda fruticosa*, *Desmostachya bipinnata* and *Phragmites karka* were the associated species. During the spring the *Typha* again gained the dominance. Kennedy *et al*. (2003), Malik & Malik (2004) and Hussain *et al*. (2005) also reported similar changes in dominance with the season and temperature. Shah & Hussain (2008) reported similar vegetation for wet lands of Akbarpura Peshawar.

The dominant geophytes (25.0%) were approached by therophytes (20.0%), nanophanerophytes, chamaephytes, microphanerophytes (each with 15.0%) and hemicryptophytes (10.0%). Leptophylls (35.05), nanophylls (30.0%), mesophylls (20.0%) and microphylls (15.0%) species (Table 13) were the components of leaf spectra. Gimenez *et al*. (2004), Batalha & Martin (2004) and Malik & Hussain (2009) reported that geophytes were rare in their respective study areas but, Shah & Hussain (2008) reported the dominance of geophytes from aquatic habitats.

2. *Euphorbia-Medicago-Malva* community (EMM)

Euphorbia-Medicago-Malva community was recognized near cultivated lands (Table 12, Appendix 14). It had 11 herb, 4 shrub, 4 tree and 1 grass species. The three dominants and the remaining species respectively had TIV of 123.4 and 176.4. Herbs

contributed 205.1, trees 52.1, shrubs 34.1 and grasses 9.1. *Acacia nilotica*, *Lathyrus aphaca*, *Euphorbia helioscopia* and *Medicago polymorpha* were sub-dominants. Similarly, Hussain (2003) and Mark *et al*. (2001) recorded seasonal plants communities which are strongly supported the present findings.

Biological spectrum consisted of therophytes (55.0%), microphanerophytes (20.0%), nanophanerophytes and chamaephytes (each with 10.0%) and hemicryptophytes (5.0%). The leaf spectrum was nano-leptophylous with few micophylls (Table 13). This site is dominated by annual or perennial weeds and clearly indicates the spring aspection and during summer these community is replaced by summer annuals. It has been reported that therophyte and leptophyllous type of community dominate in disturbed habitats (Badshah *et al*., 2010a; Mood, 2008; Sher & Khan, 2007) similar to the present one.

3. *Arnebia-Psamogeton-Malcolmia* community (APM)

At dry sandy sites *Arnebia-Psammogeton-Malcolmia* community with 20 species was established by 10 herb, 5 shrub, 3 grass and 2 tree species. The TIV of the dominants was 110.9. The remaining species had a TIV of 188.8 (Table 12, Appendix 15). Herbs dominating other groups alone contributed TIV of 189.8. Shrubs and trees, respectively, had a TIV of 59.1 and 27.5. The grasses contributed only 19.4. *Prosopis farcta*, *Periploca calophyla* and *Arnebia guttata* were the next important species in this community. This community was the richest of the reported communities in terms of number of species and species richness. All the dominants plant was annual, with flowering during spring. Generally spring is the most favorable growing and flowering season for most plants in this part of Pakistan (Wazir *et al*., 2008; Ahmad *et al*., 2008 b; Arshad *et al*., 2008).

The major life form was of therophytic (45.0%), followed by nanophanerophytes (20.0%), chamaephytes (15.0%); hemicryptophytes and microphanerophytes each had 10% share. The leaf spectra was characterized by leptophylls (45.0%), which was followed by nanophylls (30.0%), microphyll and aphyllous species each (10%) and mesophyll (5%) (Table 13). As in previous cases this site was also dominated by therophytes and leptophyll which signify the dry and disturbed condition as whole in this area (Hurka, 2004; Guo *et al*., 2009; Badshah *et al*., 2010a).

4. *Salvadora-Withania-Periploca* community (SWP)

Salvadora-Withania-Periploca community at foothills (Table 12, Appendix 16) had 12 shrub, 6 herb and 2 tree species. There were no grasses in this community. The TIV by three dominants was 152 and 147.7 by the remaining species. The contribution by shrubs was 216.1, by herbs 55.3 and by trees 28.3. The sub-dominant species were *Acacia nilotica ssp. nilotica, Peganum harmala* and *Spergularia rubra*. At foot hills *Withania* constantly dominates throughout the season because of its non-palatable nature. Malik & Hussain (2008), Arshad *et al*. (2008) and Pavlu *et al*. (2006) and Perveen *et al*. (2008) recorded similar observation in their studies which strengthen the present findings also.

The life form consisted of nanophanerophytes (40.0%), therophytes (20.0%). chamaephytes and microphanerophytes (each with 15.0%) and hemicryptophytes (10.0%). Leptophyllous (40.0%) species followed by nanophylls (20.0%) dominated the community. It was followed by aphyllous (15.0%), mesophyllous (10.0%) and microphyllous (5.0%) species (Table 13). The life form and leaf size spectra are important physiognomic attributes that have been widely used in vegetation studies. The life form spectra are said to be the indicators of micro- and macroclimate (Mark *et al*., 2001; Batalha & Martins, 2002).

5. *Taraxacum-Tamarix-Suaeda* community (TTS)

Taraxacum-Tamarix-Suaeda habituated along water courses. There were 12 herb, 5 shrub and 2 tree and 2 grass species (Table 12, Appendix 17). The dominants had TIV of 83.2 and other species shared 217.9. The contribution by herbs, shrubs, trees and grasses were 158.1, 78.9, 33.2 and 29.8 respectively. *Aerva javanica, Prosopis cineraria* and *Solanum nigrum* were sub-dominants. *Impereta cylindrica, Plantago lanceolata, Schismus barbatus* and *Veronica aquatica* associated in this community.

The major life form was therophytic (33.3%), followed by geophytes (19.0%), chamaephytes and hemicryptophytes (each with 14.3%) each nanophanerophytes and microphanerophytes (each with 9.5%). The leaf spectrum was lepto-nanophyllous (each with 33.3%). Microphylls (23.8%), mesophyll and aphyllous (each with 4.7%) were other contributor to the leaf size spectra (Table 13).

6. *Prosopis-Suaeda-Capparis* community (PSC)

The dry range lands had *Prosopis-Suaeda-Capparis* community. This was composed of one tree, 6 shrub, 6 herb and 4 grass species (Table 12; Appendix 18). A TIV of 124.9 was provided by three dominants and 174.2 by the remaining species. Shrubs had a TIV of 167.3, herbs 76.4, grasses 53.7 and trees 12.3. The sub-dominants were *Salsola foetida, Xanthium strumarium* and *Sclerochloa dura*. The associated species were *Calotropis procera, Launea nudicaulis, Conyza canadensis* and *Medicago minima*. This site was rich in terms of species due to mild and favorable condition during spring. Randal & Diaz (2006) reported that different associations depend upon seasons. Similarly, Ahmad *et al.* (2006) recorded variation in plant communities due to climate and soil as observed in the present case.

Therophytes (52.9%) were dominant, which was followed by nanophanerophytes and chamaephytes (each with 17.6%). Microphanerophytes shared 5.9%. The dominant leaf spectra was lepto-nanophyllous (each with 35.3%), followed by mesophyllous and microphyllous (each with 11.8%) and aphyllous (5.9%) species (Table 13).

D. Summer aspect

Summers are generally hot with temperature ranging between 40 - 45 ^{0}C during peak hours and days. The scarcity of rain and low humidity create an arid condition that suppresses the growth where only few species are present. During this season there were 58 species with thirty families (Table 10). The important family in terms of number of species was Poaceae with 7 sp., followed by Mimosaceae (5 sp.), Asteraceae and Asclepiadaceae each with 4 sp. The other families were Chenopodiaceae, Typhaceae and Amaranthaceae but with fewer species.

While considering the FIV, it was noted that Mimosaceae with 296.3 was leading followed by Chenopodiaceae (FIV=147.2), Poaceae (FIV=155.6), Asteraceae (FIV=147.2), Tamaricaceae, (FIV=112.6), Asclepiadcaeae (FIV=99.5) and Typhaceae (FIV=83.5). The remaining families had low status in terms of FIV (Table 10). Malik & Hussain (2004, 2006, 2008), Peer *et al.* (2007), Ahmad *et al.* (2008a) also reported the dominance of Poaceae and Asteraceae from other areas of Pakistan which are similar to our findings.

Six plant communities recognized are explained below:

1. *Tamarix-Suaeda-Phoenix* community (TSP)

Tamarix-Suaeda-Phoenix community was present at waterlogged (saline area) habitats. It had 14 species including 3 tree, 5 shrub, 4 herb and 2 grass species (Table 12, Appendix 19). A TIV of 128.7 and 171 was provided by three dominants and the remaining species, respectively. Shrubby species contributed 146.8. Tree, herbs and grasses respectively added 64.9, 61.8 and 26.1 of TIV. *Typha latifolia* and *Prosopis cineraria* were sub-dominant species in this site. *Phragmites karka, Oxystelma esculentum* and *Amaranthus graecizans* were also present in this community. Arshad *et al.* (2008) recorded that non-palatable species like *Prosopis* and *Phragmites* etc may dominate the habitat. This approach is similar results to ours findings.

Chamaephytes (28.6%) dominated the scene. It was followed by nanophanerophyte and microphanerophyte (each with 21.4%), geophytes (14.3%), therophytes and hemicryptophytes (each with 7.1%). The dominant leaf size classes were respectively leptophylls (57.1%), mesophylls (21.4%), microphylls (14.2%) and nanophylls (7.1%) (Table 13). Costa *et al.* (2007) presenting the life form and flora of thorn wood land, stated that the reserve of Caatinga vegetation was dominated by therophytes and leptophylls due to severe hot which are in accordance with our findings.

2. *Alhagi-Suaeda-Cousinia* community (ASC)

Near cultivations *Alhagi-Suaeda-Cousinia* community was recognized (Table 12, Appendix 20). It consisted of 6 herb, 4 each tree and shrub and 1 grass species. The three dominants had TIV of 143.5. The remaining species had TIV of 155.7. The contribution by herbs was 132.0, by shrubs 77.3, by trees 74.4 and by grasses 16.1. Sub dominant species were *Atriplex griffithii, Phalaris aquatica* and *Chrozophora oblongifolia*. The associated components were *Salsola foetida, Zizyphus nummularia, Tamarix aphylla* and *Medicago minima* etc. This site is dominated by summer annual like *Cousinia* and *Alhagi* but the *Suaeda* could survive up to autumn. This site is harbored mostly by herbaceous flora of short life cycle. These findings are in agreement with Malik & Hussain (2008) and Perveen *et al.* (2008) who reported communities of annual herbs in their respective study sites.

This community was surprisingly distinguished by microphanerophytes (28%) followed by therophytes (21.4%). Each of the nanophanerophytes, chamaephytes and hemicryptophytes groups shared equal values of 14.3%. Geophytes had 7.1% share. The

leaf size spectrum was shaped by nanophyll (50.0%) followed by leptophyll (42.8%) (Table 13). The present result recorded microphanerophyte and nanohphylls respectively as dominant life form and leaf size spectra. These findings are in contradiction with those of Abd El-Ghani & Amer (2003) and Batalha & Martins (2004) who reported therophytes and leptophylls as dominant during their studies.

3. *Cenchrus-Cousinia-Prosopis* community (CCP)

Cenchrus-Cousinia-Prosopis community, occupying sandy habitats (Table 12, Appendix 21), was composed of 6 herb, 5 shrub, 2 grass and 2 tree species. The dominants gathered a TIV of 132.2 and others 167.8. Herbs had TIV of 119.8, shrubs 71.7, grasses 66.6 and trees 41.7. *Prosopis cineraria, Acacia nilotica ssp. nilotica* and *Capparis decidua* were co-dominated. *Periploca calophylla, Psammogeton biternatum, Sclerochloa dura* and *Alhagi maurorum* were the associates.

The biological spectrum was dominated by therophytes (33.3%), which was followed by nanophanerophytes (26.7%), hemicryptophytes and microphanerophytes (each with 13.3% share). Chamaephytes and geophytes each had 6.7% share. The leaf spectra was structured by leptophyllous (40.0%) nanophyllous (26.7%), microphyllous and aphyllous (each with 13.3%) and mesophyllous (6.7%) species (Table 13). Sher & Khan (2007) also stated that therophytes were the main group of life form and leptophylls as the dominant leaf spectra in Chagharzai which satisfied our results in this regard. Similarly, Badshsh *et al.* (2010) and Hussain *et al.* (2009) reported therophytic and leptophyllous communities which also supported our results.

4. *Salvadora-Withania-Prosopis* (SWP)

At dry the foothills, *Salvadora-Withania-Prosopis* community was composed by 18 species including 12 shrub, 3 herb, 2 tree and only one grass species (Table 12, Appendix 22). The TIV of 3 dominants was 144.7 and 154.9 by the remaining species. Shrubs alone accumulated a TIV of 232.7, trees 28.6, herbs 25.9 and grasses 12.5. *Periploca aphylla, Acacia modesta* and *Calligonum polygonoides* were co dominants. Foot hills maintained the previous community type however the quantitative values changed.

The community was dominated by nanophanerophytic (44.4%) species. It was followed by therophytes (22.2%), chamaephytes and microphanerophytes (16.7% each).

The leaf spectra consisted of nanophylls (38.9%), leptophylls (27.8%), aphyllous species (16.7%), mesophylls (11.1%) and microphylls (5.5%) (Table 13). Manhas *et al.* (2010), Hussain *et al.* (2009), Ali & Malik (2010), and Siddiqui *et al.* (2010) reported therophytes and leptophyll as dominant life form and leaf size, respectively, in their study area. This agrees with our findings.

5. *Typha-Tamarix-Chrozophra* community (TTP)

Typha-Tamarix-Chrozophora community was established along water courses. There were 9 herb, 5 shrub and 2 tree species (Table 12, Appendix 23). The TIV of three dominants and the remaining species was 99.2 and 200.6, respectively. A major contribution of 184.0 TIV was by herbs, 77.8 by shrubs and 38 by trees. Grasses were all together absent in this community. *Prosopis cineraria, Aerva javanica, Veronica biloba* were sub-dominants. *Suaeda fruticosa, Conyza canadensis* and *Trianthema partulacastrum* etc were other recorded species in this community. Like our results, Qureshi (2008) recognized *Typha* community based on importance value in wetland of Sawan Wari of Nara Desert. Shah & Hussain (2008) also reported Typha vegetation from Akbarpura areas.

Physiognomic appearance was given by therophytes (43.7%), chamaephytes (18.7%), nanophanerophytes and microphanerophytes (each with 12.5%), geophytes and hemicryptophytes (each with 6.2%). Leaf spectrum was produced by leptophylls (43.7%) nanophylls and microphylls (each with 25%) (Table 13). Manhas *et al.* (2010) and Bocuk *et al.* (2009) recorded therophytes and leptophylls from Kandi region India.

6. *Capparis-Prosopis-Suaeda* community (CPS)

The dry range land plains had *Capparis-Prosopis-Suaeda* community (Table 12, Appendix 24), which consisted of 6 shrub, 4 herb, 2 grass and 1 tree species. The TIV of three dominants was 138.7. The remaining species had TIV of 160.9. Shrubs contributed 197.7, by herbs 52.7 and trees 17.0. *Calotropis procera, Cynodon dactylon* and *Prosopis farcta* were sub-dominants. *Convolvulus prostratus, Acacia nilotica ssp. nilotica* and *Fumaria indica* were associated species. This community had fewer numbers of species owing to aridity and dry soil during summer. Only few shrubby species existed. Some similar results were added by workers like Badshah *et al.* (2010a) from nearby Waziristan and Qureshi *et al.* (2008a) form Nara desert (Sindh) which valued our present findings.

The prominent life form class was therophytic (30.8%), followed by nanophanerophytes and chamaephytes (each with 23.1%), hemicryptophytes (15.4%) and microphanerophytes (7.6%). The leaf spectrum was dominated by leptophylls (69.2%) which was followed by nanophylls (15.0%) and mesophylls and aphyllous species (each with 7.6%) (Table 13). Here, too, the dominant life form and leaf size spectra was respectively therophytic and leptophllous Manhas *et al.* (2010) and Bocuk *et al.* (2009) recorded therophytes and leptophylls. This favored the present findings.

Edaphology

Waterlogged habitats had clay-loam soil with 7.8 pH of and low nitrogen contents (0.023%), low P (3 ppm) and high K contents (640 ppm). The organic matter was low (0.37%), but Na (3.2 ppm) were high and EC of 0.17 were low. This site appeared to be sodic. Silty-clay-loam soil near cultivated land showed high pH 8.6, N (0.07%), P (2 ppm), K (100 ppm), OM (1.12%), Na (0.3) and highest (3.45) EC. It appeared to be saline. Similarly, at sandy habitats the soil texture was sandy-clay-loam with 8.1 pH, low nitrogen (0.05%), P (4 ppm), organic matter (0.8%) and Na and EC (each with 0.3) and high K (140 ppm). The soil from foothills had 8 pH, N (0.06%), P (4 ppm) and high K (130 ppm), OM (0.96%), Na (0.3) and EC (0.13). The water courses habitats with sandy loam soil had the highest 8.6 pH, low nitrogen (0.063%), P (5 ppm), OM (1%), Na (1.3) and EC (0.92) and K (140 ppm). Range land soil had high 8.6 pH and K (280 ppm) (Table 14).

Generally the soils varied from clay loam to sandy loam while pH varied from 7.6 to 8.6, EC from 0.17 to 3.45 dSm^{-1}, N from 0.023 to 0.07 ppm, phosphorus from 2.0 to 5.0 ppm, potassium from 100 to 640 ppm, organic matter from 0.37 to 1.12 % and Na from 0.3 to 3.2 ppm (Table 14).

Table 9. Species and importance values of 24 plant communities in different aspects in District Tank.

S. #.	Species	Autumn						Winter						Spring						Summer					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Trees																								
1	*Acacia modesta* Wall.	-	-	-	15.4	-	-	-	-	-	14.2	-	-	-	-	-	12.3	-	-	-	-	-	15.0	-	-
2	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	14.7	44.6c	12.8	14.6	9.5	17.9	14.2	34.2	22.1	19.3	16.4	20.7	5.3	28.7	12.3	16.0	8.5	12.3	5.5	37.0	19.7	13.6	11.8	17.0
3	*Phoenix dactylifera* L.	26.8	-	-	-	-	-	56.9 b	-	-	-	-	-	34.5	-	-	-	-	-	34.3c	-	-	-	-	-
4	*Prosopis farcta* (Banks & Sol.) Macbride	-	15.5	21.5	-	-	-	-	8.4	29.3	-	-	-	-	5.7	15.2	-	-	-	-	10.3	23.6c	-	-	-
5	*Tamarix aphylla* (L.) Karst	40.0b	22.2	-	-	21.1	-	38.1c	8.1	-	-	16.8	-	28.9	8.6	-	-	25.1	-	25.1	10.5	-	-	26.2b	-
6	*Zizyphus mauritiana* Lam.	-	13.4	-	-	-	-	-	10.2	-	-	-	-	-	9.1	-	-	-	-	-	16.1	-	-	-	-
	Shrubs																								
7	*Abutilon bidentatum* Hochst.ex A. Rich.	-	-	-	-	5.1	-	-	-	-	-	19.3	-	-	-	-	-	8.5	-	-	-	-	-	7.1	-
8	*Atriplex griffithii* Moq.	-	10.4	-	-	-	-	-	9.8	-	-	-	-	-	9.2	-	-	-	-	-	15.8	-	-	-	-
9	*Calotropis procera subsp. hamiltonii* (Wight) Ali	-	-	14.1	5.6	-	14.1	-	-	8.6	10.2	-	55.4b	-	-	12.7	8.7	-	14.7	-	-	15.0	2.6	-	29.2

10	*Capparis decidua* (Forssk.) Edgew.	-	-	22.3	6.4	-	52.8b	-	-	13.7	16.0	-	58.8a	-	-	12.7	7.1	-	36.2c	-	-	18.6	6.5	-	51.7a
11	*Celtis eriocarpa* Decne.	-	-	-	9.9	-	-	-	-	-	10.3	-	-	-	-	-	8.2	-	-	-	-	-	11.5	-	-
12	*Calligonum polygonoides* L.	-	-	-	2.8	-	-	-	-	-	13.5	-	-	-	-	-	8.7	-	-	-	-	-	13,3	-	-
13	*Aerva javanica* (Burm. f.) Juss.	-	-	-	7.1	53.9a	-	-	-	-	10.3	17.6	-	-	-	-	7.1	24.5b	-	-	-	-	9.2	20.8	-
14	*Ficus carica* L.	-	-	-	9.5	-	-	-	-	-	10.4	-	-	-	-	-	2.9	-	-	-	-	-	5.3	-	-
15	*Periploca aphylla* Decne.	-	-	-	40.6b	-	-	-	-	-	50.5b	-	-	-	-	-	42.5c	-	-	-	-	-	19.2	-	-
16	*Periploca calophylla* (Wight) Falc.	-	-	12.0	12.7	-	-	-	-	16.6	6.8	-	-	-	-	14.3	5.7	-	-	-	-	10.4	10.4	-	-
17	*Prosopis cineraria* (L.) Druce	19.3	-	14.5	14.8	24.4	54.5a	11.8	-	11.1	14.8	39.2c	53.6c	14.1	-	9.7	7.1	23.0	50.0a	20.5	-	10.4	39.8c	23.1c	48.9b
18	*Prosopis farcta* (Banks & Sol.) Macbride	-	-	-	-	-	16.9	-	-	-	-	-	16.6	-	-	-	-	-	11.3	-	-	-	-	-	18.7
19	*Prosopis juliflora* Swartz	-	-	-	-	11.2	-	-	-	-	-	31.2	-	-	-	-	-	8.9	-	-	-	-	-	8.7	-
20	*Salsola foetida* Delile ex Spreng.	2.4	6.7	-	-	-	50.6c	8.6	2.4	-	-	-	19.9	5.3	4.5	-	-	-	16.4	8.8	9.8	-	-	-	11.1
21	*Salvadora oleoides* Decne.	-	-	18.5	60.4a	-	-	-	-	13.9	62.6a	-	-	-	-	9.7	64.6a	-	-	-	-	9.4	63.7a	-	-

22	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	8.7	9.8	-	-	11.3	22.7	17.0	13.0	-	-	62.6a	17.9	47.4b	10.5	-	-	25.5c	38.7b	49.4b	41.1b	-	-	18.1	38.1c
23	*Tamarix dioica* Roxb. ex Roth.	33.8c	-	-	-	-	-	78.4a	-	-	-	-	-	55.5a	-	-	-	-	-	60.8 a	-	-	-	-	-
24	*Vitex negundo* L.	2.4	-	-	-	-	-	4.3	-	-	-	-	-	5.3	-	-	-	-	-	7.3	-	-	-	-	-
25	*Withania coagulans* (Stocks) Dunal	-	-	-	40.6c	-	-	-	-	-	48.7c	-	-	-	-	-	44.9b	-	-	-	-	-	41.2b	-	-
26	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	-	14.3	-	13.8	-	-	-	11.1	-	11.1	-	-	-	9.9	-	8.6	-	-	-	10.6	-	10.0	-	-
	Herbs																								
27	*Achyranthes aspera* L.	3.5	-	-	-	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	*Alhagi maurorum* Medic.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.5a	11.3	-	-	-
29	*Amaranthus graecizans* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.7	-	-	-	12.2	-
30	*Amaranthus viridis* L.	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	*Anagallis arvensis* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	-	-
32	*Anethum graveolens* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	9.6	-	-	-	-	-	-	-	-	-	-
33	*Aristida adscensionis* L.	-	-	-	-	-	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	*Aristida cyanantha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.6	-	-	-	-	-

	Nees ex Steud.																								
35	*Aristida mutabilis* Trin. & Rupr.	7.1	-	-	-	-	-	16.7	-	-	-	-	-	6.1	-	-	-	-	14.0	-	-	-	-	-	-
36	*Aristida triticoides* Henr.	-	-	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*Arnebia hispidissima* (Lehm.) A. DC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.3a	-	-	-	-	-	-	-	-	-
38	*Arnebia guttata* Bunge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18.5	-	-	-	-	-	-	-	-	-
39	*Asphodelus tenuifolius* Cav.	-	-	-	-	-	-	-	5.5	58.6a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	*Astragalus amhestianus* Bth.ex. Royle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.0	-	-	-	-	-	-	-	-	-
41	*Avena sativa* L.	-	-	-	-	-	-	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	*Boerhavia procumbens* Banks ex Roxb.	-	7.9	-	-	-	-	-	-	-	-	-	-	-	-	10.0	-	-	-	-	-	-	-	-	-
43	*Cynodon dactylon* (L.) Pers.	-	-	7.3	-	-	-	-	-	-	-	-	13.2	-	9.1	-	-	-	-	-	-	-	-	-	21.5
44	*Cenchrus ciliaris* L.	-	-	-	-	-	-	-	-	-	-	-	17.9	-	-	-	-	-	-	-	-	57.6a	-	-	-
45	*Cenchrus biflorus* Roxb.	-	-	7.3	-	-	-	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	*Chenopodium album* L.	-	-	-	-	-	-	-	39.7c	-	-	-	-	-	6.2	-	-	-	-	-	-	-	-	-	-

47	*Chenopodium murale* L.	-	63.8a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	*Chenopodium ambrosioides* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	9.8	-	-	-	-	-	-	-	-	-	-	-
49	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.6	-	-	25.0	-	
50	*Chrozophora tinctoria* (L.) Raf.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.2	-	-	-	
51	*Citrullus colocynthis* (L.) Schrad.	-	-	47.1b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
52	*Cleome brachycarpa* Vohl.ex Dc.	-	-	-	-	-	-	-	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
53	*Convolvulus arvesis* L.	-	-	-	-	-	-	-	45.8a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
54	*Convolvulus microphyllus* Sieb.ex Spreng.	-	15.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.8	
55	*Convolvulus prostratus* Forssk.	-	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.6	
56	*Conyza Canadensis* (L.) Cronquist	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.4	-	-	-	-	16.1	-	
57	*Corchorus aestuans* L.	-	-	-	-	-	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
58	*Cousinia minuta* Boiss.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49.9c	55.7b	-	-	-	

59	*Cyprus rotundus* L.	7.1	-	-	-	-	-	18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	6.9	-	-	-
60	*Crambe cordifolia* Steven	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.4	-	-	-
61	*Cynoglossum lanceolatum* Forssk.	-	-	9.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	*Cymbopogon jwarancusa* (Jones) Schult.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.6	-	-	-	-	-	-	-	-	-
63	*Cyprus difformis* L.	11.5	-	-	-	-	-	-	-	-	-	57.4b	-	5.0	-	-	-	-	-	-	-	-	-	-	-
64	*Datura alba* Nees	-	-	-	-	-	-	-	-	-	-	-	-	2.9	-	-	-	-	-	-	-	-	-	-	-
65	*Desmostachya bipinnata* (L.) Stapf.	-	57.7b	-	-	-	12.3	-	-	-	-	-	-	8.0	-	-	-	-	-	-	-	-	-	-	-
66	*Dichanthium annulatum* (Forssk.) Stapf.	-	-	-	-	-	-	-	40.7b	-	-	-	15.5	-	-	-	-	-	-	-	-	-	-	-	-
67	*Echinochloa colona* (L.) Link	-	-	-	-	-	-	-	-	13.5	-	-	-	6.1	-	-	-	-	-	-	-	-	-	-	-
68	*Echinochloa crus-galli* (L.) Beauv.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.5	-	-
69	*Eclipta alba* (L.) Hassk.	-	-	-	-	14.8	-	10.0	-	-	-	-	-	3.9	-	-	-	-	-	-	-	-	-	-	-
70	*Emex spinosus* (L.) Campd.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.4	-	-	-	-	-	-	-	-	-
71	*Emex australis* Steinh.	-	-	-	-	-	-	-	-	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

72	*Equisetum arvense* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.3	-	-	-	-	-	-	-
73	*Eragrostis minor* Host	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.8	-	-	9.6	-	-	-	-	-	-
74	*Euphorbia dracunculoides* Lam.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	-	-	-	-	-	-	-	-
75	*Euphorbia granulata* Forssk.	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
76	*Euphorbia helioscopia* L.	-	-	-	-	-	-	-	-	-	-	-	-	2.0	47.5a	-	-	-	-	-	-	-	-	-	-
77	*Euphorbia prostrata* Ait.	-	-	-	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	6.2	-	-	-	-	-	-
78	*Euphorbia thymefolia* L.	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
79	*Fagonia indica* var. *schweinfurthii* Hadidi	-	-	-	15.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	*Fumaria indica* (Hausskn.) Pugsley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.7	-	-	-	-	-	-	-	11.6
81	*Gastrocotyle hispida* (Forssk.) Bunge	-	-	-	-	-	-	-	-	42.5b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
82	*Halostachys belangerana* (Moq.) Botsch.	-	-	-	-	-	16.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83	*Heliotropium europaeum* L.	-	-	-	-	-	-	-	-	-	-	-	-	9.6	-	-	-	10.7	-	-	-	-	-	-	-
84	*Hypericum perforatum* L.	-	-	-	-	-	-	-	-	36.6c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

85	*Imperata cylindrica* L.	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.2	-	-	-	-	-	-	-	-
86	*Lathyrus aphaca* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	16.2	-	-	-	-	-	-	-	-	-	-	-
87	*Launaea nudicaulis* (L.) Hook.f.	-	-	-	-	10.7	-	-	-	-	-	-	-	-	-	-	-	-	10.8	-	-	-	-	-	-	-
88	*Malcolmia africana* (L.) R. Br.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.8c	-	-	-	-	-	-	-	-	-	-
89	*Malva neglecta* Wallr.	-	-	-	-	-	-	-	8.6	-	-	-	-	-	35.4c	-	-	-	9.6	-	4.8	-	-	-	-	-
90	*Malvastrum coromandelianum* (L.) Garcke	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.8	-	-	-	-	-	-	-	-
91	*Medicago polymorpha* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	40.5b	-	-	-	-	-	-	-	-	-	-	-
92	*Medicago minima* (L.) Grufb	-	-	-	-	-	-	-	-	-	-	-	-	-	10.3	4.7	-	-	10.6	-	10.2	-	-	-	-	-
93	*Melilotus indica* (L.) All.	-	-	-	-	-	-	-	8.8	-	-	-	-	-	11.2	-	-	-	-	-	-	-	-	-	-	-
94	*Ochthochloa compressa* (Forssk.) Hilu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	-	-	-	-	-	-	-	-	-	-
95	*Oligomeris linifolia* (Vahl.) Macbride	-	-	-	-	-	-	-	-	-	-	-	-	-	10.4	-	-	-	-	-	-	-	-	-	-	-
96	*Oxystelma esculentum* (L. f.) R. Brown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.1	-	-	-	-	-	-
97	*Panicum antidotale* Retz.	-	-	-	-	-	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

98	*Panicum capillare* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.2	-	-	-	-	-	-
99	*Coronopus didymus* (L.) Smith	-	-	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100	*Portulaca quadrifida* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	-	-	-	-	-	-	-	-
101	*Peganum harmala* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.3	-	-	-	-	-	-	-	-
102	*Phalaris aquatica* L.	-	-	-	-	-	-	-	-	-	-	--	-	-	-	-	-	-	-	-	16.0	-	-	-	-
103	*Phragmites karka* (Retz.) Trin. ex Steud.	32.5	-	-	-	-	-	-	-	-	-	-	-	9.9	-	-	-	-	-	17.5	-	-	-	-	-
104	*Plantago ciliata subsp. lanata* (Boiss.) Rech.	-	-	6.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.9	-	-
105	*Plantago lanceolata* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.2	-	-	-	-	11.8	-	-
106	*Plantago major* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	-	-	-	-	-	13.4	-
107	*Poa annua* L.	-	-	-	-	-	-	-	-	-	-	17.6	10.2	-	-	-	-	-	-	-	-	-	-	-	-
108	*Poa infirma* H. B. K	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.7
109	*Polygonum patulum* M. Bieb.	3.5	-	-	-	19.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110	*Polygonum plebejum* R. Br	-	-	-	-	-	-	-	8.6	-	-	-	-	-	-	-	-	8.9	-	-	-	-	-	-	-
111	*Psammogeton biternatum* Edgew.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.8b	-	-	-	-	-	17.6	-	-	-
112	*Pulicaria crispa* (Forssk.) B.H.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.7

113	*Ranunculus sceleratus* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.9	-	4.4	-	-	-	-	-
114	*Reseda odorata* L.	-	-	-	-	-	-	-	6.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
115	*Rumex dentatus* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.9	-	-	-	-	-	-	-
116	*Rumex obtisifolius* L.	-	-	-	-	48.5b	-	-	-	-	-	-	-	3.9	-	-	-	-	-	-	-	-	-	-	-
117	*Saccharum munja* Roxb.	-	-	48.7a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
118	*Saccharum spontaneum* L.	-	-	-	9.7	-	-	-	-	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
119	*Sclerochloa dura* (L.) P. Beauv.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.9	-	-	11.2	-	-	-
120	*Schismus barbatus* (L.) Thell.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.5	-	-	-	-	-	-	-
121	*Setaria verticillata* (L.) P. Beauv.	-	-	-	-	-	-	-	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122	*Solanum nigrum* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.0	-	-	-	-	-	14.9	-
123	*Solanum surattense* Burm. f.	-	-	-	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
124	Sonchus asper (L.) Hill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.2	-	-	-	-	-	-	-	-	-
125	*Spergula arvensis* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.3	-	-	-	-	-	-	-	-
126	*Spergularia marina* (L.) Griseb.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.3	-	-	-	-	-	-	-	-
127	*Taraxacum officinale* F. H. Wigg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.6a	-	-	-	-	-	14.8	-

128	*Trianthema portulacastrum* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.9	-
129	*Tribulus terrestris* L.	-	-	35.9c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
130	*Tricholepis chaetolepis* (Boiss.) Rech. f.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.1	-	-	-	-	-	-	-	-	-
131	*Typha latifolia* L.	52.5 a	-	-	-	-	-	24.7	-	-	-	21.5	-	36.1c	-	-	-	-	-	33.6	-	-	-	49.9a	-
132	*Typha minima* Funck ex Hoppe	-	-	-	-	34.4c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
133	*Urtica pilulifera* L.	-	-	-	-	-	-	-	-	-	-	-	-	9.9	-	-	-	-	-	-	-	-	-	-	-
134	*Veronica aquatica* Bern.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.9	-	-	-	-	-	-	-
135	*Veronica biloba* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	-	-	-	-	-	19.8	-
136	*Vicia faba* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	-	-	-	-	-	-	-	-	-	-
137	*Viola stocksii* Boiss.	-	-	-	-	-	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
138	*Xanthium strumarium* L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.2	-	-	-	-	-	-

Table 10. Number of species and Family Importance Value (FIV) in recorded plant families in different seasons of District Tank.

S. #.	Family	Autumn		Winter		Spring		Summer	
		Species	FIV	Species	FIV	Species	FIV	Species	FIV
1	Aizoaceae	-	-	-	-	-	-	1	17.9
2	Amaranthaceae	3	86.2	1	12.5	1	31.6	2	52.9
3	Apiaceae	-	-	-	-	2	43.4	1	17.6
4	Arecaceae	1	26.8	1	56.9	1	35.5	1	34.3
5	Asclepiadaceae	3	99.8	2	141.3	3	98.6	4	99.5
6	Asphodelaceae	-	-	1	64.1	-	-	-	-
7	Asteraceae	2	25.5	1	10	6	109.9	4	147.2
8	Boraginaceae	1	9.0	1	42.5	3	82.1	-	-
9	Brassicaceae	1	11.1	-	-	1	33.8	1	11.4
10	Capparidaceae	1	28.7	2	101.5	1	56	1	76.8
11	Caryophyllaceae	-	-	-	-	2	17.6	-	-
12	Chenopodiaceae	5	118.2	4	97.4	4	173.5	3	192.2
13	Convolvulaceae	2	47.1	1	45.8	-	-	2	30.4
14	Cucurbitaceae	1	47.1	-	-	-	-	-	-
15	Cypraceae	2	18.6	2	75.9	-	-	1	6.9
16	Euphorbiaceae	3	30.8	-	-	3	63.9	1	48.8
17	Equisetaceae	-	-	-	-	1	15.3	-	-
18	Fumariaceae	-	-	-	-	1	9.7	1	11.6
19	Hypericaceae	-	-	1	36.6	-	-	-	-
20	Malvaceae	1	5.8	2	27.9	3	62.3	2	11.9
21	Mimosaceae	5	309.9	5	301.7	5	240.3	5	296.3
23	Moraceae	1	9.5	1	10.4	1	2.9	1	5.3
24	Nyctaginaceae	1	7.9	-	-	1	10	-	-
25	Papilionaceae	-	-	1	8.8	5	101.5	2	74
26	Portulacaceae	-	-	-	-	1	8.5	-	-
27	Plantaginaceae	-	-	-	-	2	20.7	3	33.1

28	Poaceae	10	233.2	10	175.6	9	140	7	155.6
29	Polygonaceae	3	74.7	3	33.4	5	75.6	1	13.3
30	Primulaceae	-	-	-	-	-	-	1	6.2
21	Ranunculaceae	-	-	-	-	1	15.9	1	4.4
22	Resedaceae	-	-	1	6.8	-	-	-	-
23	Rhamnaceae	2	41.6	2	32.4	2	27.6	2	36.7
24	Salvadoraceae	1	78.9	2	76.5	1	74.3	1	73.1
25	Scrophulariaceae	-	-	-	-	2	19.4	1	19.8
26	Solanaceae	2	52.6	1	48.7	3	64.8	2	56.1
27	Tamaricaceae	2	117.1	2	141.4	2	118	2	112.6
28	Tiliaceae	1	8.9	-	-	-	-	-	-
29	Typhaceae	2	86.9	1	46.2	1	36.1	2	83.5
30	Ulmaceae	1	9.9	1	10.3	1	8.2	1	11.5
31	Urticaceae	-	-	-	-	1	9.9	-	-
32	Verbinaceae	1	2.4	1	4.3	1	5.3	1	7.3
33	Violaceae	1	6.1	-	-	-	-	-	-
34	Zygophyllaceae	2	51.2	-	-	1	8.2	-	-
	Total	61	-	50	-	77	-	58	-

Table 11. Index of Similarity between occurrences of species in different seasons of District Tank.

X	Autumn	Winter	Spring	Summer
Autumn	X			
Winter	67.7	X		
Spring	65.7	52.7	X	
Summer	65.6	66.6	73.5	X

Table 12. Number of species and total Importance values (TIV) of trees, shrub and herbaceous species in different communities and seasons of District Tank.

Seasons	Autumn						Winter						Spring						Summer					
Communities/ habitat	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
A. Number of species																								
Total species	18	13	16	17	15	13	12	19	14	14	10	11	20	20	20	20	21	17	14	14	15	18	16	13
1.Trees	3	4	2	2	2	1	3	4	2	2	2	1	3	4	2	2	2	1	3	4	2	2	2	1
2. Shrubs	5	4	5	12	5	6	5	4	5	12	5	6	5	4	5	12	5	6	5	4	5	12	5	6
3. Herbs	6	4	5	2	7	3	3	8	5	0	2	0	8	11	10	6	12	6	4	5	6	3	9	4
4. Grasses	4	1	4	1	1	3	1	3	2	0	1	4	4	1	3	0	2	4	2	1	2	1	0	2
B. TIV by each group																								
a. TIV By 3 Dominants	126.3	174.1	131.7	141.6	136.8	157.9	173.4	125.1	137.7	161.8	159.2	167.8	139	123.4	110.9	152	81.5	124.9	129	144	132.2	144.7	99.2	138.7
b. By the Remaining species	173.2	125.6	167.5	158.1	163.2	141.7	125.8	174.8	161.8	137.3	140.5	131.9	160.7	176.4	188.8	147.7	218.5	174.2	171	156	167.8	154.9	200.6	160.9
c. By trees	78.2	95.7	34.3	30	30.6	17.9	109.2	60.5	51.4	33.5	33.2	20.7	68.7	52.1	27.5	28.3	33.2	12.3	64.9	74.4	41.7	28.6	38	17
d. By shrubs	66.7	41.2	81.4	233.8	105.9	211.6	120.1	40.2	63.9	265.2	169.9	222.2	127.6	34.1	59.1	216.1	78.9	167.3	147	77.3	71.7	232.7	77.8	197.7
e. By herbs	94.2	97.5	110.2	26.4	152.3	31.4	53.2	134.5	162	0	78.9	0	73.3	205.1	189.8	55.3	158.1	76.4	61.8	132	119.8	25.9	184	52.7
f. By grasses	60.4	65.7	74.3	9.7	11.5	38.8	16.7	64.8	21.9	0	17.6	56.8	30.1	9.1	19.4	0	29.8	53.7	26.1	16	66.6	12.5	0	0

Key: 1. = Water logged; 2 = Cultivated land; 3 = Plains sandy area; 4 = Dry foot hills; 5 = Water courses; 6 = Dry plains Range land

Table 13. Life form and Leaf size spectra of plant communities in different seasons of District Tank.

Season	Autumn						Winter						Spring						Summer					
Communities	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
A. Life form spectra																								
Therophytes	22.2	23.1	18.7	11.8	20	7.7	8.3	36.8	21.4	0	10	9.1	20	55	45	20	33.3	52.9	7.1	21.4	33.3	22.2	43.7	30.8
Nanophanerophytes	16.7	15.3	25	47	13.3	30.1	25	10.5	28.6	57.1	20	27.2	15	10	20	40	9.5	17.6	21.4	14.3	26.7	44.4	12.5	23.1
Chamaephytes	16.7	15.3	12.5	23.5	20	23.1	16.6	10.5	21.4	21.4	30	27.2	15	10	15	15	14.3	17.6	28.6	14.3	6.7	16.7	18.7	23.1
Geophytes	27.8	0	0	0	26.7	7.7	25	10.5	7.1	0	20	0	25	0	0	0	19	0	14.3	7.1	6.7	0	6.2	0
Hemicryptophytes	0	15.3	31.2	0	6.7	30.1	0	10.5	7.1	0	0	27.2	10	5	10	10	14.3	0	7.1	14.3	13.3	0	6.2	15.4
Microphanerophytes	16.7	30.7	12.5	17.6	13.3	7.7	25	21.1	14.3	21.4	20	9.1	15	20	10	15	9.5	5.9	21.4	28.6	13.3	16.7	12.5	7.6
B. Leaf size spectrum																								
Leptophylls	50	46.1	43.7	41.2	46.7	53.8	50	42.1	35.7	35.7	70	72.7	35	45	45	40	33.3	35.3	57.1	42.8	40	27.8	43.7	69.2
Nanophylls	33.3	53.8	25	17.6	33.3	15.4	33.3	52.6	28.6	21.4	20	9.1	30	50	30	30	33.3	35.3	7.1	50	26.7	38.9	25	15.4
Mesophylls	16.7	0	6.2	11.8	13.3	7.7	16.6	0	7.1	14.3	10	9.1	20	0	5	10	4.7	11.8	21.4	0	6.7	11.1	6.2	7.6
Microphylls	0	0	12.5	1.8	6.7	15.4	0	5.3	14.3	7.1	0	0	15	5	10	5	23.8	11.8	14.2	7.1	13.3	5.5	25	0
Aphyllous	0	0	12.5	17.6	0	7.7	0	0	14.3	21.4	0	9.1	0	0	10	15	4.7	5.9	0	0	13.3	16.7	0	7.6

Key: 1. = Water logged; 2 = Cultivated land; 3 = Sandy area; 4 = Foot hills; 5 = Water courses; 6 = Range l

Table 14. Physico-chemical features of soils of different habitats of District Tank.

Habitats	Soil texture	pH	N (%)	P (ppm)	K (ppm)	Om (%)	Na (ppm)	EC ds/m
Water logged	Clay-loam	7.8	0.023	3	640	0.37	3.2	0.17
Near Cultivated land	Silty-clay-loam	8.6	0.07	2	100	1.12	0.3	3.45
Plains Sandy land	Sandy-clay-loam	8.1	0.05	4	140	0.8	0.3	0.3
Dry Foothills	Sandy-clay	8	0.06	4	130	0.96	0.3	0.13
Water courses	Sandy loam	8.6	0.063	5	140	1	1.3	0.92
Dry plains Rangeland	Clay-loam	8.6	0.068	3	280	1.08	1.6	1.57

Regeneration capacity

Age classes within a population are the ratio of various age groups to each other at given time. The age structure has been used as a guide to timber and fuel management. The diameter of trunk at breast level or dbh has been used as an indicator of age on the assumption that diameter increases with age. The greater the diameter the older is the tree. But with their growth suppressed by lack of height, moisture or nutrients, understory trees and even so called seedling and sapling add little to their diameter. Although the diameter size suggests youth, small trees, often are the same age as large individuals in the canopy (Smith & Smith, 1998; Chaughtai *et al*., 1983). The regeneration capacity for tree species was known by placing the recorded individuals of species in different girth classes.

Age pyramids help visualize structure of a population. As the population changes with time, the number of individuals in each age class also changes. A large number of young individuals which expand the base of the pyramid characterize a growing population. This large class of young eventually moves up into the reproductive age class. A higher proportion of individuals moving into the older age classes characterize a declining population. With fewer young individuals will enter the reproductive age classes, further depressing the population. In this way age structure change over time (Malik & Hussain, 2008).

The number of trees of each of the species in different girth classes is presented in Table 15. It was observed that none of the tree species had fair distribution of individuals in various defined classes. There were gaps of various classes. Mature trees (121-300) and over mature trees (300 cm +) were present sporadically. The young individuals especially *Zizyphus mauritiana*, *Prosopis farcta* and *Acacia modesta* were few, showing very slow growth. *Acacia nilotica ssp. nilotica* and *Phoenix dactylifera* had some plants in the young category. These justify the regeneration capacity in these two species. *Tamarix aphylla* and *Acacia nilotica ssp. nilotica* was almost present in all the girth classes. These species were found under heavy stress by all sort of utilization but their constant presence showed its fast growing and vegetative reproduction as compared to *Prosopis farcta* and *Zizyphus mauritiana*. Few individual of *Prosopis farcta* in the high girth classes indicated the conservation of this species as timber wood. The results show

an alarming state of lack of regeneration and degradation of most tree vegetation. These trees are present sparsely with wide open canopy. Unlike to ours, Martinkova *et al.* (2004, 2006) reported prominent regeneration strategy in the communities in their studies due to less anthropogenic interference. Lososova *et al.* (2006a) stated that the species composition of urban environments may be related to the diverse regeneration strategies of that species. Similarly, Prach *et al.* (2001) and Lososova *et al.* (2006b) recorded that frequent disturbances play a major role in shaping plant communities in urban environments. This is also true in the present case as the majority of the lands have converted to barn treeless lands. Benvenuti (2004) reported that trampling, vehicular movement and building activities frequently affect vegetation and, hence, only those species capable of regenerating after repeated disturbance become residents of urban habitats Our results are in line with him because of constantly utilization for timber, fuel and fodder forages and the plants get rare chances for regeneration in District Tank.

Degree of homogeneity

Of the six plant communities in autumn, 4 were homogenous. While in winter two were homogenous. There were 4 homogenous and two heterogeneous communities in spring. During summer 5 communities were heterogeneous and one homogenous (Table 16). The majority of the community showing heterogeneity might be due to the presence of large number of annuals and habitat degradation, climate, soil conditions, deforestation, overgrazing, trampling and soil erosion in the research area. All the sites lie within the same general climate and similar climatic and soil condition. The area is disturbed which result in more species in class A to C. Some of the age classes were missing in the investigated area which is due to deforestation and anthropogenic interruption. These findings agree with other workers (Malik & Hussain, 2008; Shiyomi *et al.*, 2001). While the homogeneity nature of the plant community was attributed to fewer species that had uniform distribution especially woody species in the investigated area. There were almost similar edaphic condition such as soil moisture, degree of erosion, organic matter and nutrient to create a uniform habit. Durrani (2000) also recorded 40% homogeneity in different plants communities of Harboi range which are similar to the present case.

Index of Diversity and its Components

Species diversity is an important character of any vegetation that not only reflects the health of vegetation but also its productivity. Index of diversity is the measure of complexity of form and function within a community. Its precise measurement leads to understanding of process involved in the developmental changes and organization of communities (Shoukat *et al*., 1978; Malik & Hussain, 2009). Species diversity reflects the impact of different factors such as over grazing, deforestation, environmental stress as susceptibility of species to these factors lowers the species diversity (Willoughby & Alexander, 2000, 2005). Index of diversity among communities increased from 9.01 in autumn to 10.56 in spring at saline habitat. Similarly, it was lowest 5.87 in autumn and highest 10.36 in spring near cultivated land. At sandy habitat species diversity varied from 8.35 in summer to 12.81 in spring. The low (9.40) species diversity was recorded in winter and high (15.66) in autumn at the foot hill habitat. At water courses it varied from 7.84 during winter to 20.04 in spring. While it ranged from 9.72 in winter to 15 during spring at rangeland area (Table 17). The overall situation tells that index of diversity among communities increased from 8.68 near cultivated area in autumn to 12.97 at water courses habitat in spring (Table 18). Since the stands at cultivated area and water courses have mixed forest, therefore the maximum diversity indicates slight succession stage. These findings are in line with those of Adhikari *et al*. (1991) who reported high diversity near water courses similar to the present trends. Malik *et al*. (2003) recorded high species diversity in the upper reaches of vegetation of Dao Khun while low diversity at lower altitude. Similarly, the present study also observed high and low species diversity based on habitat feature, water contents and climate.

Highest species richness of 2.08 was recorded at foothills during spring that gradually decreased to 1.18 in dry plains rangelands during autumn (Table 17). Pant & Samant (2007) reported that high richness may be due to diverse habitats and suitable edaphic and climatic factors supporting growth and survival of the species. This is also true in the present case where favorable temperature made the habitat suitable for plants. On water logged habitats, the species richness was slightly high during spring and summer as in dry habitat moisture plays the major role. The species richness along stream banks (1.3) was low due to aquatic condition. Central Himalayan region which are most

Periploca-Withania communities was 68.1%, between *Salvadora-Periploca-Withania* and *Salvadora-Periploca-Withania* communities 64.9%; between *Prosopis cineraria-Capparis-Prosopis farcta* and *Capparis-Calotropis-Prosopis* communities 64.4%; between *Typha-Tamarix-Tamarix* and *Tamarix-Suaeda-Typha* communities 60% (Table 19).

Low similarity was seen between *Typha-Tamarix-Tamarix* and *Tamarix dioica-Phoenix-Tamarix aphylla* (57.6%), *Tamarix dioca-Phoenix-Tamarix aphylla* and *Tamarix-Suaeda-Typha* (55%) communities, *Prosopis cineraria-Capparis-Prosopis farcta* and *Prosopis-Suaeda-Capparis* (54.5%) communities and *Prosopis-Suaeda-Capparis* and *Capparis-Prosopis-Suaeda* communities (54.3%). The remaining communities had less than (50%) similarity among themselves. The communities exhibiting least similarity were mainly composed of large number of spring and autumn annuals that disappeared in the next season. This created the differences among seasonal aspect and similarity.

Malik & Hussain (2008) reported that four of the fifteen plants communities showed more than 60% similarity which are in line with present situation. The higher similarities between the communities might be due to the feature like similarity in nutrients, proximity of stands to each other which almost had similar habitat conditions in terms of pH, phosphorus and soil from clay loam to sandy loam. The present findings are in agreement with those of Shah *et al*. (1991), Durrani (2000), Malik & Hussain (2008) and Badshah *et al*. (2010a) who reported that differences among the plant communities is due to landscape, exposure, erosion and biotic factors.

Table 15. Regeneration capacity of some selected tree species as indicated by number of individuals in each girth class in District Tank.

S. No.	Girth classes (cm)	*Acacia nilotica ssp. nilotica*	*Acacia modesta*	*Tamarix aphylla*	*Phoenix dactylifera*	*Zizyphus mauritiana*	*Prosopis farcta*
1.	1 – 30	20	01	21	0	02	14
2.	31 – 60	08	04	0	20	0	06
3.	61 – 90	13	0	0	12	06	0
4.	91 – 120	07	0	0	12	02	0
5.	121 – 150	14	02	22	0	0	0
6.	151 - 180	0	0	11	0	0	05
7.	181 – 210	11	0	0	0	0	0
8.	211 – 240	0	01	11	0	0	0
9.	241 – 270	08	0	07	0	0	0
10.	271 – 300	0	0	0	0	0	04
11.	301 – 330	06	0	04	0	0	0
		R	NR	R	R	NR	NR

Table 16. Degree of homogeneity based on Frequency Classes in different plant communities of District Tank.

Aspect	Communities	Number of species in various Frequency classes					Remarks
		A	B	C	D	E	
	A. Water logged						
Autumn	*Typha-Tamarix aphylla-Tamarix dioica*	4	6	3	3	2	Heterogeneous
Winter	*Tamarix dioica - Phoenix-Tamamrix aphylla*	3	6	1	1	0	Heterogeneous
Spring	*Tamarix dioica Suaeda-Typha*	10	5	0	5	1	Heterogeneous
Summer	*Tamarix-Suaeda-Phoenix*	4	4	1	4	1	Heterogeneous
	B. Near Cultivated land						
Autumn	*Desmostachya-Chenopodium-Acacia*	3	6	1	1	2	Homogenous
Winter	*Convolvulus-Chenopodium-Diacanthium*	5	10	0	2	2	Homogenous
Spring	*Euphorbia - Medicago-Malva*	3	13	0	2	2	Homogenous
Summer	*Alhagi-Suaeda-Cousinia*	3	6	1	4	0	Heterogenous
	C. Sandy area						
Autumn	*Saccharum - Citrullus - Tribulus*	1	7	4	2	2	Homogenous
Winter	*Asphodelus-Gastrocotyle - Hypericum*	0	8	1	2	3	Homogenous
Spring	*Arnebia-Psammogeton-Malcolmia*	3	10	3	0	4	Homogenous

Summer	*Cousinia - Cenchrus - Prosopis*	4	5	3	3	1	Heterogeneous
	D. Foot hills						
Autumn	*Salvadora-Periploca-Withania*	6	6	2	1	2	Homogenous
Winter	*Salvadora-Pericploca-Withania*	4	6	1	2	1	Heterogeneous
Spring	*Salvadora-Withania-Periploca*	10	6	1	2	1	Heterogeneous
Summer	*Salvadora-Withania-Prosopis*	6	5	4	2	1	Heterogeneous
	E. Water courses						
Autumn	*Aerva-Rumex-Typha*	1	9	2	2	1	Heterogeneous
Winter	*Suaeda-Prosopis-Prosopis*	0	6	3	1	0	Heterogeneous
Spring	*Taraxacum-Suaeda - Aerva*	3	11	4	3	0	Heterogeneous
Summer	*Typha-Tamarix-Prosopis*	0	9	5	1	1	Homogenous
	F. Rangeland						
Autumn	*Prosopis-Capparis-Prosopis*	1	4	5	1	2	Homogenous
Winter	*Capparis-Calotropis-Prosopis*	0	5	3	2	1	Heterogeneous
Spring	*Prosopis-Suaeda-Capparis*	0	6	8	1	2	Heterogeneous
Summer	*Capparis-Prosopis-Suaeda*	0	6	2	5	0	Heterogeneous

Table 17. Species Diversity, Species Richness and Maturity Index of plant communities of District Tank.

Aspect	Communities	Species diversity	Species richness	Maturity index
	A. Waterlogged habitat			
Autumn	*Typha-Tamarix aphylla-Tamarix dioica*	9.01	1.57	43.9
Winter	*Tamarix dioica-Phoenix-Tamamrix aphylla*	9.89	1.53	40
Spring	*Tamarix dioica - Suaeda - Typha*	10.56	1.89	35.8
Summer	*Tamarix-Suaeda-Phoenix*	9.87	1.4	47.6
	B. Cultivated lands			
Autumn	*Desmostachya -Chenopodium -Acacia*	5.87	1.36	45.1
Winter	*Convolvulus-Chenopodium-Dichanthium*	9.51	1.62	40.4
Spring	*Euphorbia -Medicago-Malva*	10.36	1.67	42.8
Summer	*Alhagi-Suaeda-Cousinia*	8.98	1.45	44.7
	C. Sandy area			
Autumn	*Saccharum-Citrullus-Tribulus*	11.37	1.47	51.7
Winter	*Asphodelus-Gastrocotyle-Hypericum*	9.09	1.39	51.9
Spring	*Arnebia-Malcolmia-Psammogeton*	12.81	1.62	45.5
Summer	*Cousinia -Cenchrus-Prosopis*	8.35	1.47	42.7
	D. Foot hills			
Autumn	*Salvadora-Periploca-Withania*	15.66	1.8	40.6
Winter	*Salvadora-Periploca-Withania*	9.4	1.6	41.4
Spring	*Salvadora-Withania-Periploca*	12.16	2.08	25.7
Summer	*Salvadora-Withania-Prosopis*	12.67	1.84	40.7

	E. Water courses			
Autumn	*Aerva-Rumex-Typha*	11.18	1.34	43.8
Winter	*Suaeda-Prosopis-Prosopis*	7.84	1.24	43.7
Spring	*Taraxacum-Suaeda-Aerva*	20.04	1.75	39.8
Summer	*Typha-Tamarix-Prosopis*	12.83	1.34	45.6
	F. Rangelands			
Autumn	*Prosopis-Capparis-Salsola*	10.99	1.18	53.6
Winter	*Capparis-Prosopis-Calotropis*	9.72	1.23	52.4
Spring	*Prosopis-Suaeda-Capparis*	15	1.42	53.3
Summer	*Capparis-Prosopis-Suaeda*	13.57	1.32	54.3

Table 18. Overall situation of species diversity, species richness and maturity index (average values) in different communities of District Tank.

	Species diversity	Species richness	Maturity index
A . Seasonal responses			
Autumn	10.68	1.45	46.45
Winter	09.29	1.43	44.96
Spring	13.48	1.73	40.48
Summer	11.04	1.47	45.93
B . Habitat responses			
Water logged habitat	09.83	1.59	41.82
Cultivated lands	08.68	1.52	43.25
Sandy habitat	10.40	1.48	47.95
Foot hills	12.47	1.83	37.10
Water courses	12.97	1.41	43.22
Rangelands	12.32	1.28	53.40

Table 19. Index of Similarity between plant communities harboring various habitats in different seasons of District Tank.

X																								
TTT	X																							
DCA	16.0	X																						
SCT	9.1	13.1	X																					
SPWi	9.8	4.9	23.3	X																				
ART	20.7	14.3	8.0	10.5	X																			
PCP	15.1	16.7	21.2	13.8	15.1	X																		
TPT	57.6	17.7	8.2	8.7	21.3	18.5	X																	
CCD	11.3	27.3	7.21	8.6	9.6	11.1	12.9	X																
AGH	8.6	12.5	28.2	12.6	6.9	17.1	8.4	12.0	X															
SPW	9.8	10.1	24.0	64.9	11.6	18.7	8.7	10.1	24.5	X														
SCP	27.9	14.4	9.1	12.0	32.0	23.5	20.0	12.5	9.2	13.9	X													
CCP	15.1	24.4	23.7	13.8	15.1	64.4	17.2	17.2	18.1	20.1	28.0	X												
TST	60.0	15.7	6.4	6.5	20.0	18.5	55.0	9.6	7.5	6.5	33.8	14.2	X											
EMM	12.2	28.6	6.2	10.1	9.5	10.8	12.6	36.7	9.3	6.4	11.9	15.0	10.3	X										
APM	7.3	9.2	25.0	15.6	6.4	15.8	7.3	6.9	27.6	20.5	7.3	12.6	5.0	7.4	X									
SWP	7.3	8.2	20.0	68.1	5.5	13.0	7.1	8.2	19.5	76.9	10.1	13.0	4.1	8.2	16.9	X								
TTS	17.7	13.5	7.7	10.1	34.2	18.1	20.8	5.5	6.5	1.2	36.3	16.5	26.6	9.2	6.4	7.6	X							
PSC	16.6	8.2	21.1	13.1	20.7	54.5	21.3	12.1	15.3	17.8	30.1	53.1	23.2	15.8	20.3	1.8	19.0	X						
TSP	46.6	14.8	1.8	6.8	20.8	19.9	64.2	9.7	5.5	6.8	41.2	17.6	75.8	9.7	5.1	4.2	27.1	24.6	X					
ASC	12.1	32.8	7.7	8.4	10.4	16.8	16.8	34.8	10.8	10.0	22.7	16.2	17.3	34.4	9.1	8.2	14.8	20.3	22.3	X				
CCP	10.7	11.8	29.5	19.0	6.6	20.4	10.5	9.4	33.9	24.1	8.9	27.3	5.2	8.5	33.4	18.0	6.3	18.7	5.3	30.5	X			
SWPr	11.0	7.9	23.9	72.9	14.4	20.9	8.5	7.9	17.9	72.0	20.78	11.1	6.5	7.8	17.1	69.3	13.6	20.4	8.7	7.9	17.7	X		
TTP	38.7	11.4	8.8	11.3	33.3	17.7	30.6	6.6	7.6	12.3	41.7	17.6	21.3	10.3	7.2	8.7	37.2	17.7	37.9	18.4	7.4	14.7	X	
CPS	15.1	8.0	27.4	13.0	15.1	61.0	17.2	10.8	16.8	19.4	31.3	68.7	21.0	13.7	15.8	16.2	19.0	54.3	24.4	21.7	20.4	17.5	17.7	X

Key: TTT = *Typha-Tamarix-Tamarix;* DCA = *Desmostachya-Chenopodium-Acacia*; SCT = *Saccharum-Citrullus-Tribulus;* SPWi = *Salvadora-Periploca-Withania;* ART = *Aerva-Rumex-Typha;* PCP = *Prosopis cineraria-Capparis-Prosopis farcta*; TPT = *Tamarix dioca-Phonex-Tamarix aphylla*; CCD = *Convolvulus-Chenopodium-Dichanthium;* AGH = *Asphodelus-Gastrocotyle-Hypericum;* SPW = *Salvadora-Periploca-Withania;* SCP = *Suaeda-Cyprus-Prosopis;* CCP = *Capparis-Calotropis-Prosopis;* TST = *Tamarix-Suaeda-Typha*; EMM = *Euphorbia-Medicago-Malva*; APM = *Arnebia-Psammogeton-Malcolmia;* SWP = *Salvadora-Withania-Periploca;* TTS = *Taraxacum-Tamarix-Suaeda;* PSC = *Prosopis-Suaeda-Capparis;* TSP = *Tamarix-Suaeda-Phoenix*; ASC = *Alhagi-Suaeda-Cousinia;* CCP = *Cenchrus-Cousinia-Prosopis;* SWPr = *Salvadora-Withania-Prosopis;* TTP = *Typha-Tamarix-Chrozophra;* CPS = *Capparis-Prosopis -Suaeda.*

Ordination Classification

I. Cluster Analysis

Based on cluster dendrogram analysis the following four plants associations could be recognized. Each one is confined to a definite habitat features composed of characteristic species which is briefly discussed as follow:

1. Wood land and herbaceous association

The vegetation in this association consisted of *Chenopodium murale* (IV= 63.8), *Tamarix dioica* (IV= 57.2) and *Capparis decidua* (IV= 49.3). *Chenopodium murale* acquired the highest importance value amongst the arboresent members and formed the herbaceous layer. *Tamarix dioica* and *Capparis decidua*, respectively dominated the shrub layer (Table 20). The association consisted of 12 communities and was supported by 81 species including 20 woody (Fig. 2). This association accommodated majority of the communities due to their similar habitat requirement and life form.

2. Xerosere herbaceous association

This association is predominantly dominated by annual and perennial herbaceous species. *Asphodelus tenuifolius* (IV= 58.6), *Cousinia minuta* (IV= 55.7) and *Cenchrus ciliaris* (IV= 51.6) in the herbaceous layer and *Tamarix aphylla* in the tree layer while *Capparis decidua* in the shrub layer dominated the association (Table 20). The association was comprised of 4 communities with 39 component species including 6 woody species (Fig. 2). The component communities were: *Saccharum-Citrullus-Tribulus, Asphodelus-Gastrocotyle-Hypericum, Arnebia-Psammogeton-Malcolmia* and *Cenchrus-Cousinia-Prosopis*. Other important associated herbs included *Alhagi maurorum, Convolvulus arvensis* and *Cleome brachycarpa*. The components of this association dry habitat loving plants soon complete its life cycle before the onset of severe climatic condition.

3. Thorny woody association

This association spread throughout the dry habitats with shrubby and spiny herbaceous association. There were 42 species including 12 woody species (Table 20). *Capparis decidua* (IV= 51.7) and *Prosopis cineraria* (IV= 48.9) were respectively dominated in shrub layer. While *Alhagi maurorum* (IV= 52.5), *Cousinia minuta* (IV= 49.9) and *Euphorbia helioscopia* (IV= 47.5) were dominant in the herb layer. *Acacia*

nilotica ssp. *nilotica*, *Calotropis procera*, *Suaeda fruticosa*, *Convolvulus arvensis* and *Dichanthium annulatum* were the other important species. This association was composed of four plant communities (Fig 2): *Convolvulus-Chenopodium-Dichanthium*, *Euphorbia-Medicago-Malva*, *Alhagi-Suaeda-Cousinia* and *Capparis-Prosopis-Suaeda*.

4. Degraded woody association

This association was present at the foot hills. Here, *Salvadora oleoides* (IV= 62.7) was dominant along with *Periploca aphylla* (IV= 38.2) and *Withania coagulans* (IV= 33.8) as the co-dominant (Table 20). *Fagonia indica var. schweinfurthii*, *Prosopis cineraria*, *Acacia nilotica* and *Astragalus amherstianus* were next common species. All the grasses were tufted, perennial and rhizomatous. This group also comprised of 4 plant communities including *Salvadora-Periploca-Withania*, *Salvadora-Withania-Periploca* and *Salvadora-Withania-Prosopis*. This association comprised of medicinal plants at the bottom of the hills where there is scarcity of water and the plants are under stress for various purposes. The soil over here is sandy and low in moisture contents, therefore the plants associated are of xeric nature and composed of perennial grasses.

Similar results were recorded by Ahmad (2004, 2009) who stated that cluster analysis and TWINSPAN grouped different communities into few associations in District Abbottabad. Jafari *et al*. (2007) also reported that 90 plots vegetation was clustered into seven main types based on environmental need which is in line with our findings. Lyon & Gross (2005) used DCA to evaluate the assemblage of various vegetation communities based on frequency value. This also supported our findings. Similar findings were also reported by He *et al*. (2007) who recognized the vegetation into six major associations by simple DCA and cluster dendrogram. Yeo & Blackstock (2001) classified the vegetation of uplands wale UK into six biogeographical groups due to different assemblage of vegetation and habitat types which strengthen the present findings. Similarly, Xianping *et al*. (2006) quantified communities into seven groups using DCA in the forest communities in Pangquangou National Nature Reserve also favor our results.

Like ours, Baruch (2005) studied the vegetation environmental relationship in Venezuela and grouped many communities into fewer by clustering, TWINSPAN and detergent correspondence analysis (DCA). The present results also agree with that of Enright *et al*. (2005) who studied the desert vegetation of Kirthar National Park Pakistan

reported different associations of annual and perennial plant by simple clustering and graph ordination. The degraded woody association comprised of only 28 species where the species diversity was optimum due to xeric condition and the high browsing and cutting pressure also trigger this decrease. Such kind of species diversity has also been observed in other mountainous ecosystem (Anderson *et al*., 2006; Nogue´s-Bravo *et al*., 2008; Sheikh *et al*., 2002; Kharkwal *et al*., 2005; Ahmad, 2007).

II. Detrended Correspondance Analysis (DCA)

Unlike cluster ordinatation, the DCA classified the 24 plant communities into 5 groups and one outlier. The largest group was composed of eight communities near cultivated land (st 2, st 5, st 8, st 11, st 14, st 17, st 20 and st 23) as group I (Fig. 3). In this association most of the grasses and woody grouped due to their high importance values and mat forming and similar habitat nature. The main vegetation consisted of *Tamarix aphylla, Aerva Javanica,, Chenopodium Rumex obtisifolius, Typha latifolia, Convolvulus arvensis, Dichanthium annulatum* and *Cynodon dactylon*. Similarly, Ahmad *et al*. (2004) reported that *Cynodon dactylon* and *Cenhrus ciliaris* grouped together due to high density and cover and similarly in habitat feature which supported our results. Our results also agree with that of Naqinezhad *et al*. (2008) who recorded five vegetation groups by DCA and correlated with major environmental gradients. This group possessed similar soil texture i.e. silt clay soil and with high N and pH values made the association. The rest of the groups i.e. II, III and IV each possessed 4 communities with almost similar type of soil structure and N and pH concentration. Riverd *et al*. (2000) and Hejcmanova & Hejcman (2006) stated that vegetation is significantly influenced by soil chemistry and altered the floristic composition and productivity which in our case strongly support this where seen no significant variation due to similar soil types and level topography in the investigated area. Communities (st 6, st 18 and st 24) joined into Vth group with almost sandy and saline habitat and less concentration of N and pH. The species present in this group were *Capparis decidua, Salsola foetida, Phoenix dactylifera, Prosopis cineraria* and *Suaeda fruticosa*. This group was designated as *Capparis-Phoenix-Prosopis* group due to their highest importance values. These communities develop on the bottom of the foot hills on the dry and saline soil and can be regarded as degraded community. Human disturbances like over grazing, cutting for fuel and timber,

looping and deforestation have frequently sonserved.This association although influenced by soil types and salt concentration did not show altitudinal variation. These findings are in line with that of Jiang *et al*. (2007) who recorded the significant change in vegetation along the altitudinal gradients in Helan Mountains in China. Jabeen & Ahmad (2009) recorded four major associations by using graphic ordination in Ayub National Park Rawalpindi also in agreement with the present results. The community (st 12) outlier and did not participate in the association due to clay loam habitat and low nitrogen concentration (Fig. 3). This community is consisted of *Calotropis procera*, *Peripoloca aphylla* and *Prosopis cineraria* as the dominant vegetation. Due to their xeric feature these plants outlier in the DCA graph. These associations were correlated with habitat feature, pH of the soil and Nitrogen contents in the soil. One of the most important components controlling vegetation diversity and cover is the soil and topography amongst other things (Solon *et al*., 2007) which has also been observed in these findings.

Over all majority of the species were grouped in the center of diagram and no obvious variation in the soil composition and nutrients seem to be influencing the grouping of the species. However the pH and Nitrogen concentration play significant role in the grouping of few species.

Table 20. Mean relative importance values of species in 4 associations by cluster analysis in District Tank.

S. No.	Species	Associations			
		I	II	III	IV
1	*Abutilon bidentatum* Hochst.ex A. Rich.	10	0	0	0
2	*Acacia modesta* Wall.	0	0	0	14.2
3	*Acacia nilotica ssp. nilotica* (L.) Delile	15.1	16.7	29.3	15.8
4	*Achyranthes aspera* L.	14	0	0	0
5	*Aerva javanica* (Burm. f.) Juss.	29.2	0	0	8.4
6	*Alhagi maurorum* Medic.	0	11.3	52.5	0
7	*Amaranthus graecizans* L..	11.4	0	0	0
8	*Amaranthus viridis* L.	10.2	0	0	0
9	*Anagallis arvensis* L.	0	0	0	6.2
10	*Anethum graveolens* L.	0	0	9.6	0
11	*Aristida adscensionis* L.	14.3	0	0	0
12	*Aristida cyanantha* Nees ex Steud.	8.6	0	0	0
13	*Aristida mutabilis* Trin. & Rupr.	11	0	0	0
14	*Aristida triticoides* Henr.	0	11	0	0
15	*Arnebia guttata* Bunge	0	18.5	0	0
16	*Arnebia hispidissima* (Lehm.) A. DC.	0	43.3	0	0
17	*Asphodelus tenuifolius* Cav.	0	58.6	5.5	0
18	*Astragulus amhestianus* Bth.ex. Royle	0	0	0	11
19	*Atriplex griffithii* Moq.	10.4	0	11.6	0
20	*Avena sativa* L.	0	0	12.5	0
21	*Boerhavia procumbens* Banks ex Roxb.	7.9	10	0	0
22	*Calligonum polygonoides* L.	0	0	0	10.1
23	*Calotropis procera subsp. hamiltonii* (Wight) Ali	32.9	12.6	29.2	6.8
24	*Capparis decidua* (Forssk.) Edgew.	49.3	16.8	51.7	9
25	*Celtis eriocarpa* Decne.	0	0	0	9.9

26	*Cenchrus biflorus* Roxb.	0	7.3	12.1	0
27	*Cenchrus ciliaris* L.	17.9	51.6	0	0
28	*Chenopodium album* L.	0	0	22.9	0
29	*Chenopodium ambrosioides* L.	0	0	9.8	0
30	*Chenopodium murale* L.	63.8	0	0	0
31	*Chrozophora oblongifolia* (Delile) Adr. Juss. ex Spreng.	25	0	14.6	0
32	*Chrozophora tinctoria* (L.) Raf.	0	9.2	0	0
33	*Citrullus colocynthis* (L.) Schrad.	0	47.1	0	0
34	*Cleome brachycarpa* Vahl.ex Dc.	0	13	0	0
35	*Convolvulus arvesis* L.	0	0	45.8	0
36	*Convolvulus microphyllus* Sieb.ex Spreng.	15.6	0	14.8	0
37	*Convolvulus prostratus* Forssk.	0	10.9	15.6	0
38	*Conyza canadensis* (L.) Cronquist	14.2	0	0	0
39	*Corchorus astuans* L.	8.9	0	0	0
40	*Coronopus didymus* (L.) Smith.	0	0	0	11.1
41	*Cousinia minuta* Boiss.	0	55.7	49.9	0
42	*Crambe cordifolia* Steven	0	11.4	0	0
43	*Cymbopogon jawarancusa* (Jones) Schult.	0	5.6	0	0
44	*Cynodon dactylon* (L.) Pers.	13.2	7.3	15.3	0
45	*Cynoglossum lanceolatum* Forssk.	9	0	0	0
46	*Cyprus difformis* L.	24.6	0	0	0
47	*Cyprus rotundus* L.	12.8	6.9	0	0
48	*Datura alba* Nees	2.9	0	0	0
49	*Desmostachya bipinnata* (L.) Stapf.	26.1	0	0	0
50	*Dichanthium annulatum* (Forssk.) Stapf.	15.5	0	40.7	0
51	*Echinochloa colona* (L.) Link	6.1	0	13.5	0
52	*Echinochloa crus-galli* (L.) P. Beauv.	0	0	0	12.5
53	*Eclipta alba* (L.) Hassk.	9.6	0	0	0
54	*Emex australis* Steinh.	0	11.3	0	0

55	*Emex spinosus* (L.) Campd.	0	11.4	0	0
56	*Equisetum arvense* L.	15.3	0	0	0
57	*Eragrostis minor* Host	9.6	8.8	0	0
58	*Euphorbia dracunculoides* Lam.	0	0	0	8.8
59	*Euphorbia granulata* Forssk.	11.3	0	0	0
60	*Euphorbia helioscopia* L.	2	0	47.5	0
61	*Euphorbia prostrata* Ait.	9.1	0	0	0
62	*Euphorbia thymefolia* L.	7.1	0	0	0
63	*Fagonia indica* var. *schweinfurthii* Hadidi.	0	0	0	15.3
64	*Ficus carica* L.	0	0	0	7
65	*Fumaria indica* (Hausskn.) Pugsley	11.1	0	0	9.7
66	*Gastrocotyle hispida* (Forssk.) Bunge	0	42.5	0	0
67	*Halostachys belangerana* (Moq.) Botsch.	16.4	0	0	0
68	*Heliotropium europaeum* L.	10.1	0	0	0
69	*Hypericum perforatum* L.	0	36.6	0	0
70	*Imperata cylindrica* L.	14.1	0	0	0
71	*Lathyrus aphaca* L.	0	0	16.2	0
72	*Launaea nudicaulis* (L.) Hook.f.	12.8	0	0	0
73	*Malcolmia africana* (L.) R. Br.	0	33.8	0	0
74	*Malva neglecta* Wallr.	9.6	0	16.3	0
75	*Malvastrum coromandelianum* (L.) Garcke	8.8	0	0	0
76	*Medicago minima* (L.) Grufb	10.6	4.7	10.2	0
77	*Medicago polymorpha* L.	0	0	40.5	0
78	*Melilotus indicus* (L.) All.	0	0	10	0
79	*Ochthochloa compressa* (Forssk.) Hilu	0	5	0	0
80	*Oligomeris linifolia* (Vahl.) Macbride	0	0	10.4	0
81	*Oxystelma esculentum* (L. f.) R. Brown	13.1	0	0	0
82	*Panicum antidotale* Retz.	12.2	0	0	0
83	*Panicum capillare* L.	15.2	0	0	0
84	*Peganum harmala* L.	0	0	0	11.3

85	*Periploca aphylla* Decne.	0	0	0	38.2
86	*Periploca calophylla* (Wight) Falc.	0	13.3	0	9.2
87	*Phalaris aquatica* L.	0	0	16	0
88	*Phoenix dactylifera* L.	38.1	0	0	0
89	*Phragmites karka* (Retz.) Trin. ex Steud.	19.9	0	0	0
90	*Plantago ciliata subsp. lanata* (Boiss.) Rech.	6.3	0	0	7.9
91	*Plantago lanceolata* L.	16.2	0	0	11.8
92	*Plantago major* L.	8.9	0	0	0
93	*Poa annua* L.	13.9	0	0	0
94	*Poa infirma* H. B. K.	0	0	10.7	0
95	*Polygonum patulum* M. Bieb.	11.7	0	0	0
96	*Polygonum plebejum* R. Br.	8.9	0	8.6	0
97	*Portulaca quadrifida* L.	0	0	0	8.5
98	*Prosopis cineraria* (L.) Druce	23.3	17.1	48.9	19.1
99	*Prosopis farcta* (Shrub) (Banks & Sol.) Macbride	15.5	19.1	8.1	0
100	*Prosopis farcta* (Tree) (Banks & Sol.) Macbride	14.7	0	18.7	0
101	*Prosopis juliflora* Swartz	15	0	0	0
102	*Psammogeton biternatum* Edgew.	0	25.7	0	0
103	*Pulicaria crispa* (Forssk.) B. H.	0	0	10.7	0
104	*Ranunculus scleratus* L.	10.1	0	0	0
105	*Reseda odorata* L.	0	0	6.8	0
106	*Rumex dentatus* L.	8.9	0	0	0
107	*Rumex obtisifolius* L.	26.2	0	0	0
108	*Saccharum munja* Roxb.	0	48.7	0	0
109	*Saccharum spontaneum* L.	0	8.4	0	9.7
110	*Salsola foetida* Delile ex Spreng.	14.8	0	6.9	0
111	*Salvadora oleoides* Decne.	0	12.8	0	62.7

112	*Schismus barbatus* (L.) Thell	14.5	0	0	0
113	*Sclerochloa dura* (L.) P. Beauv.	14.9	11.4	0	0
114	*Setaria verticillata* (L.) P. Beauv.	0	0	11.8	0
115	*Solanum nigrum* L.	15.9	0	0	0
116	*Solanum surattense* Burm. f.	12	0	0	0
117	*Sonchus asper* (L.) Hill	0	11.2	0	0
118	*Spergula arvensis* L.	0	0	0	6.3
119	*Spergularia rubra* (L.) Griseb.	0	0	0	11.3
120	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	27.4	0	25.6	0
121	*Tamarix aphylla* (L.) Karst	27.1	20.1	9.1	0
122	*Tamarix dioica* Roxb. ex. Roth.	57.2	0	0	0
123	*Taraxacum officinale* F. F. Wigg.	25.7	0	0	0
124	*Trianthema portulacastrum* L.	17.9	0	0	0
125	*Tribulus terrestris* L.	0	0	35.9	0
126	*Tricholepis chaetolepis* (Boiss.) Rech. f.	0	12.1	0	0
127	*Typha latifolia* Edgew.	36.4	0	0	0
128	*Typha minima* Funck ex Hoppe	34.4	0	0	0
129	*Urtica pilulifera* L.	9.9	0	0	0
130	*Veronica aquatica* Bern.	14.9	0	0	0
131	*Veronica biloba* L.	12.3	0	0	0
132	*Vicia faba* L.	0	0	8	0
133	*Viola stocksii* Boiss.	6.1	0	0	0
134	*Vitex negundo* L.	4	0	0	0
135	*Withania coagulans* Dunal	0	0	0	33.8
136	*Xanthium strumarium* L.	16.2	0	0	0
137	*Zizyphus mauritiana* Lam.	13.4	0	11.8	0
138	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	14.1	0	10.5	9.9

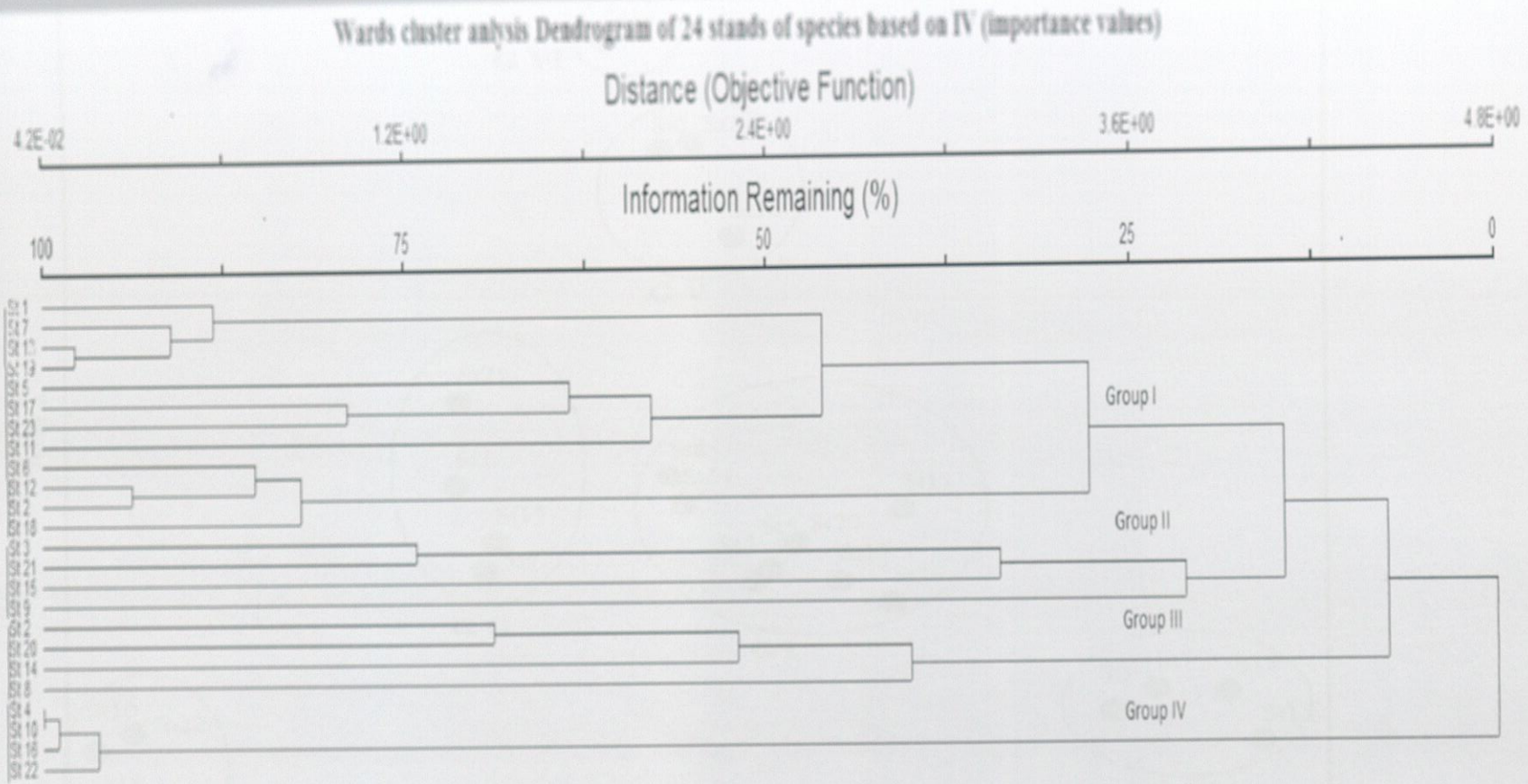


Fig. 2. Cluster Dendrogrm Analysis showing 4 associations of 24 plant communities based on IV (Importance values) in District Tank.

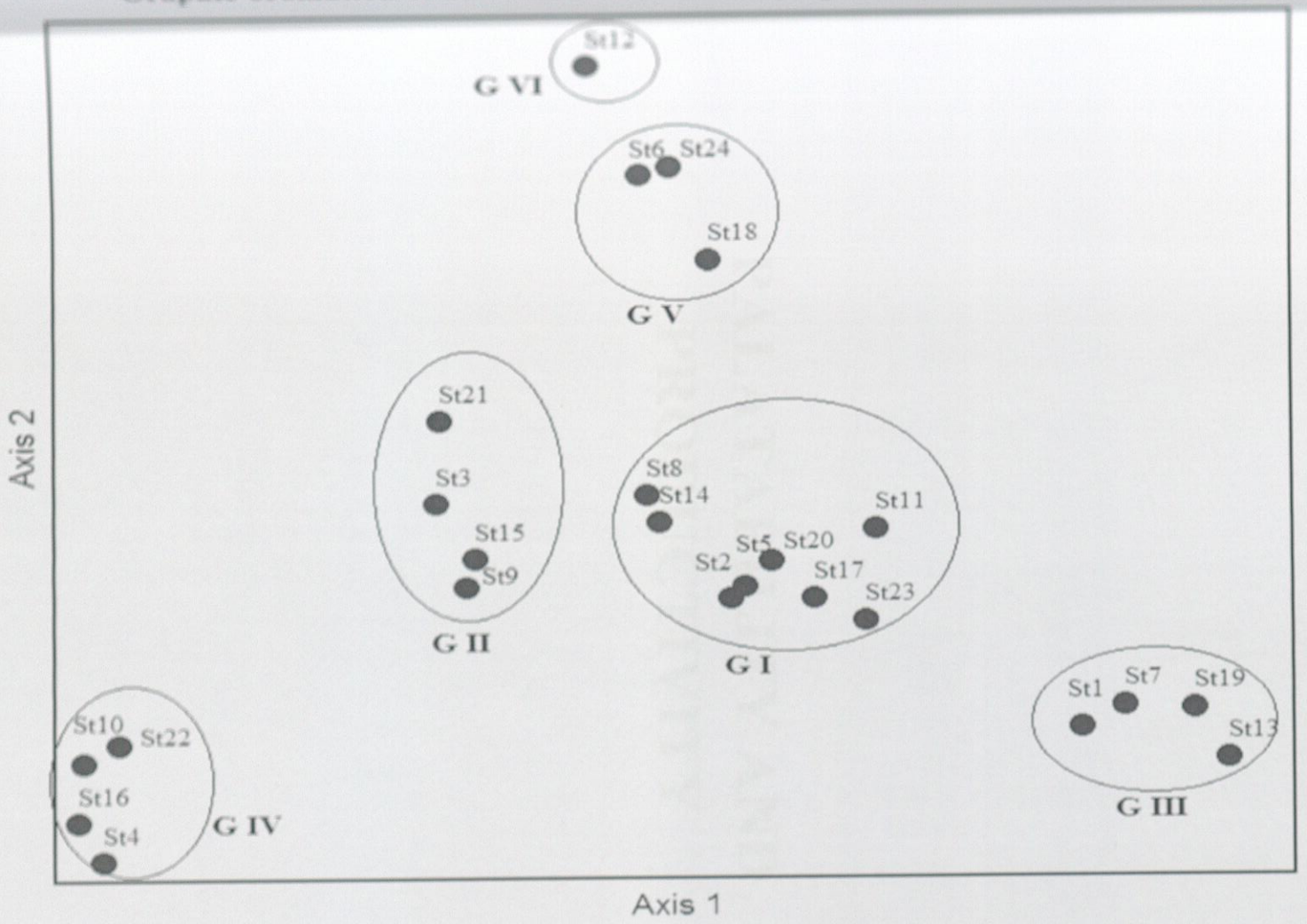


Fig. 3. Groups demarcated by Detrended Correspondence Analysis of 24 plants communities in District Tank.

PALATABILITY AND PRODUCTIVITY

PALATABILITY AND PRODUCTIVITY

I. Palatability

1. Degree of Palatability

Palatability refers to the plant attributes which determines its acceptability by grazing animals. Characteristics of plant species such as chemical composition, growth stage, external plant form and kinds of plant affect the acceptability and may stimulate selective responses by animals or may prevent from grazing (Heady, 1964).

There were 205 species, which belonged to 58 families. Of them 56 species (27.3%) were non palatable due to their habit and poisonous nature. There were 149 palatable species with varying degrees of palatability. The ratio of palatable to total species was 1: 1.3 and non palatable to the total was 1: 3.7. They included 33 species (16.1%) which were highly palatable, 33 species (16.1%) mostly palatable, 42 species (20.4%) less palatable and 43 species (20.9%) were rarely palatable (Table 21). Herbivory is strongly avoided due to nature and fragrant of the plants (Lee *et al*., 2000). This in an agreement with the present work which described some 56 non palatable species due to spiny nature and un acceptable taste. Heavy grazing has changed the structure and physiognomy of the vegetation. Karki *et al*. (2000) are in view that grazing may hamper the structure and function of the ecosystem.

Among the trees 6 species (60%) were highly palatable, 3 (30%) were rarely palatable and one species (10%) was non palatable. The livestock generally preferred *Acacia modesta* and *Zizyphus mauritiana* during winter and early spring. Grazing animal reduced woody plant cover and decrease scrub encroachment. However, the impact varies with kind of grazing animal and nature of woody plants. Among woody species only *Prosopis cineraria* and *P. juliflora* were least browsed and not damaged due to their unpalatable nature. *Tamarix aphylla* and *Calotropis procera* were seldom grazed. Cattle and goat usually prefer leaves of *Zizyphus mauritiana* and *Acacia nilotica*. Neal & Miller (2007) and Akram *et al*. (2009) reported that *Zizyphus* was markedly browsed and deformed, while on the contrary *Phoenix* was seldom affected. This is in line with our findings where heavy grazing has reduced the tree into prostate habit. Range land plants differ greatly in palatability, nutritive value and productivity. Tree and shrub seedlings became more abundant, but browsing effectively prevented regeneration of vegetation (Mountford & Peterken, 2003) which is similar to our findings. A poor management in the present situation therefore resulted in the complete replacement of good quality forage plants by non palatable plants such as *Salvadora oleoides* and *Withania coagulans*. The findings agree with those of Seymour *et al*. (2010) who reported that after deforestation and continuous grazing, the rest years has ensured the growth and

dominance of non palatable species such as *Pteronia pallens* to palatable species. The removal of plants also caused accelerated soil erosion in the bare lands of the area (Fig 4).

Among shrubs, 2 (6.9%) were highly palatable, 3 (10.3%) were most palatable, 7 (24.1%) were less palatable and 9 (31.0%) were rarely palatable; while 8 (27.6%) shrubs were non palatable. There were 34 species of palatable grasses including 13 (38.2%) highly palatable, 10 (29.4%) mostly palatable, 3 (8.8%) less palatable and 8 (23.5%) rarely palatable (Table 21). Palatability of a given plant species for a given livestock type changes with the season or stage of maturity. Herbaceous species at the early stage of the growth are highly palatable probably due to their high nutritional contents and soft texture while certain plants like *Calotropis procera* and *Prosopis cineraria* were palatable only during post reproductive and mature stages. Certain trees and shrub such as *Acacia nilotica ssp. nilotica* and *Ziziphus mauritiana* that retain their foliage round the year may continue to be highly palatable. These findings are in line with that of Watson & Smith (2000) who stated that most of the grasses were eaten in the early stages when grasses could offer young green foliage. In the present study 60% of the trees were highly palatable, 30% were rarely palatable and one species was non palatable. The livestock generally preferred *Acacia modesta* and *Zizyphus mauritiana* during winter and early spring due to young foliage.

2. Preference by livestock

Palatability of plants depends upon nutritional need and energy of animals. It declines as need are met (Provenza, 1996). Among the palatable species 72 species were grazed by sheep. They included 42 (58.3%) herbs, 22 (30.5%) grasses, 3 (4.2%) shrubs and 5 (7.0%) trees. Goat preferred 66 species which included 27 (40.9%) herbs, 16 (24.2%) grasses, 14 (21.2%) shrubs and 9 (13.6%) trees. Similarly camel and cow respectively preferred 40 and 36 of the species (Table 21). The preference for herbaceous forbs species was highest by sheep and cattle and grasses and woody by goat and camel. These findings are in agreement with those of Angasa & Baars (200) and Husain & Durrani (2007), who stated that goat and sheep usually preferred forbs and shrubs while, cattle prefer grasses.

3. Classification by part used

It was found that in 82 (40%) species shoots/ whole plants were used. In 61 (29.7%) species foliage/ leaves were used while in 8 (3.9%) floral parts were consumed (Table 21). A number of plants morphological characteristics such as spines, hairs, stickiness, rigidity, coarse texture and unfavorable odor or chemical natures reduce the palatability. These findings are in line with Milewsk & Madden (2006) and Hussain &

Durrani (2009a), who stated that intensive browsing led plants to produce long thorn against browsing. Palatability is a relative factor and depends upon on the availability and nature of forage and kinds of animals. The chemical nature such as nutritive value and mineral contents cause variation in selection of plant part of the same plants by grazing animals. The plant part with less nutrition or containing harmful chemicals is generally avoided.

4. Classification by condition used

Among the palatable species 54 (36.2%) species were utilized in fresh condition and 44 (29.5%) in dry condition. While 51 (34.3%) were consumed both in fresh and dry condition (Table 21). Our findings are supported by Knop & Smith (2006) who recorded changes in the extent of grazing different plant species. Similarly, Miller & Thampson (2005) observed that *Fetuca* and *Agrostis* were both palatable in fresh condition during summer and dried during winter. But the intensity of palatability is high during summer. Similarly, green herbaceous are easily digestible than dried and mature plants. Cattle prefer foliage than dried forage. The choice of dried plant material declines owing to taste, odor and feel (Holechek & Galt, 2000). A similar trend was noticed in the present study where most of the grasses like *Avena sativa*, *Cymbopogan jwarncusa*, *Echinchloa* and *Dichanthium annulatum* were preferred more in fresh condition. In the present fresh forage drastically declines therefore the livestock owners store dried forage for stall feeding. The livestock use these forage even though they may not prefer it.

5. Non palatable species

There were 56 (27.3%) non palatable species due to various reasons. They included shrubs like *Withania coagulans, Abutilon bidentatum, Nerium indicum, Rhazya stricta, Vitex negundo* and *Arnebia guttata. Centeurium spicatum*, *Chrozophora oblongifolia*, *Cousinia minuta* and *Datura alba* were among non palatable herbs (Table 21). Some species such as *Peganum harmala, Euphorbia helioscopia* and *Cassia senna* were considered as poisonous to livestock. Some of the recorded species in the preset study might be harmful to livestock owing to their unfavorable chemical composition or textural morphology such as *Peganum harmala, Euphorbia helioscopia* and *Casia angustifolia*. It might be possible that poor health and performance of livestock in this area are partly due to grazing these toxic species. Since there is always shortage of forage in the area, therefore, these less to non- palatable species are grazed under compulsion as no other choice is available to the livestock. Towhidi & Zhandi (2007) reported that due to lack of fodder non palatable plants like *Salsola*, *Alhagi*, *Tamarix* and *Haloylon* etc are grazed under compulsion in Iran. Same is true in our study. *Calotropis procera* and *Tamarix aphylla* are non palatable in other parts of the world but in district Tank these

are grazed under compulsions. Hirata *et al*. (2005) evaluated that the higher cover of herbaceous vegetation showed higher grazing impacts which reduced the total available forage at the end of the growing season by the end of the dry season. On the contrary, light grazing impact would occur with a higher cover of shrub vegetation types. The importance of maintaining plant cover over the rangeland area is maintained by simulated gazing. The proportion of most palatable species decreased in response to overgrazing while the proportion of unpalatable species increased. In our case *Withania*, *Alhagi* and *Chenopodium* were present as non palatable and *Zizyphus*, *Acacia* and grasses as palatable species. Here too the proportion of most palatable species decreased due to over exploitation and overgrazing.

6. Availability of species

The availability of fodder species during the year depended upon the season. There were 138 species available in spring, 100 species in summer, 78 species in winter and 76 species in autumn. The perennial species like *Capparis decidua, Zizyphus nummularia*, *Desmostachya bipinnata* and *Cenchrus biflorus* were available throughout the year. It was observed that majority of the highly palatable species were available during spring followed by summer season that gradually declined from autumn to winter season. The species which were highly preferred by sheep were available during spring and summer and therefore it had better choice for fodder. The fodder choice was limited during winter and late summer because of dormant period (Table 22).

It is obvious that during winter and dormant stage the amount and variety of forage species decrease. Similar approach was reported by Brits *et al*. (2002); Hickman *et al*. (2004), Chocarro *et al*. (2005), Hirata *et al*. (2005), Palvu *et al*. (2006), Neal & Miller (2007) and Akram *et al*. (2009). Hussain & Durrani (2009a) also stated that winter period always had scarcity of the fodder species in Harboi rangeland. Less palatable species like *Atriplex griffithii*, *Calotropis procera*, *Haloxylon multiflorum*, *Phragmites karka*, *Withania coagulans* and *Kochia indica* etc increased in their occurrence and growth in the area because of less preference by animals. Novaro *et al*. (2002) reported similar results that *Prosopis glandulosa* which grows abundantly in the grazing lands owing to its low palatability in Chihuahuan deserts. Goyal & Sinha (1996) and Okoti *et al*. (2004) reported that pastoral grazing has replaced palatable grasses by unpalatable species and decrease forage due to intense livestock grazing. In our case similar situation was seen. Palatable grasses such as *Cenchrus biflorus, Cymbopogon jwarancusa* and *Avena etc* have replaced by *Desmostachya bipinnata* and *Panicum capillare* etc.

Loeser *et al*. (2007) and Peters *et al*. (2007) reported that *Bromus tectorum* declined in the area due to overgrazing throughout the year, therefore effect of grazing on

species composition were greatest and high rate of utilization significantly reduced the proportion and occurrence of *Bromus*. In our case, *Cynodon* and *Aristida mutabilis* were highly palatable species grazed by cattle at high intensities throughout the year, therefore these grasses got reduced proportionally. Randal & Diaz (2006) also stated that plant cover over time was negative under heavy grazing but positive under light and without grazing which is in accordance with our findings where heavy grazing and browsing has resulted the land into deserts.

In general selectivity of forage is directly proportion to the amount of herbage available. This is important to see that several annual grasses and forbs grow in season when woody vegetation is dormant. So these grasses provide an important forage contribution to livestock and minimize pressure on perennial during growing season (Malik *et al*., 2000; Akram *et al*., 2009; Hussain & Durrani, 2009). Same is the case in District Tank, where annual grasses and forbs appear when most of the shrubby components are still dormant. Thus, it provides a chance for shrubs to produce vegetative growth and by the time annual mature, woody and perennial forage becomes available.

II. Forage productivity

A. Productivity of herbaceous plants

Biomass, a measure of resources of a community, is tied up in different species. Vegetation composition based on dry weight is one of the best indicators of the species importance within a plant community (Bonham, 1989). In the dry rangeland of District Tank the above ground herbaceous biomass production on dry matter basis was 2336 Kg/h. The recorded biomass for herbaceous was quite low as compared to other parts of the country due to non- productive land and low rain fall and prevailing extreme temperature throughout the year. Malik (2005) reported 19250 kg/h from Azad Kashmir and Badshah *et al*. (2010a) some 200 kg/h from South Waziristan. The relative proportion of biomass constituted by the major species also varied with stand age and anthropogenic activity in the area (Sah *et al*., 2004; Liddell *et al*., 2007).

a. Grasses

It was observed that maximum dry biomass of (430 Kg/h) was provided by cultivated land followed by plants present in water courses (356 Kg/h) (Table 23). Waterlogged and sandy area, respectively produced 91 Kg/h and 314 Kg/h biomass. Foot hills and dry land were less productive as they yielded 169 kg/h and 54 Kg/h biomass respectively. The productivity by grasses at sandy sites gradually increased from winter to spring (50 - 100 Kg/h) and thereafter it declined in summer (90 Kg/h). During spring the productivity was highest (150 Kg/h) followed by winter (120 Kg/h) and autumn (100 Kg/h) in cultivated land. Summer was less productive as it gave only 60 Kg/h forage. The

dry land yielded poor biomass. It was highest in spring (18 Kg/h) which decreased to 5 Kg/h in winter, autumn (15 Kg/h) and summer 16 Kg/h. It was observed that maximum dry biomass of 635 Kg/h was provided by cultivated land followed by plants present in water courses 598 Kg/h. Waterlogged and sandy area, respectively produced 411 Kg/h and 442 Kg/h biomass. Foot hills and dry land were less productive as they yielded 181 kg/h and 69 Kg/h biomass, respectively. The low productivity recorded at dry habits was probably due to long grazing spell and transhumance of nomadic people which resulted in poor growth of vegetation and incomplete life cycle. Timothy *et al.* (2005) observed that timing and duration of grazing have dramatic effect on the productivity of ecosystem. Similarly in waterlogged the productivity was high in spring (36 Kg/h) followed by autumn with (30 Kg/h). Winter and summer seasons were less productive respectively with 5 Kg/h and 20 Kg/h.

In spring the productivity was at the peak (123 Kg/h) in water courses which reduced to (30 Kg/h) in summer. Autumn was the second highest (110 Kg/h) productive season in water courses. Likewise, in foothills spring had maximum productivity (73 Kg/h) followed by autumn (63 Kg/h). Winter and summer was less productive with none and 33 Kg/h respectively (Table 23).

b. Forbs

This included herbs other than grasses. It was observed that maximum biomass of forbs (180 Kg/h) was recorded in water logged habitat during autumn followed by spring (120 Kg/h). During winter and summer the biomass was 10 Kg/h for each season. It was observed that the forbs productivity was the second highest in water courses. This habitat produced 95 Kg/h each during spring and autumn. Winter and summer were less productive respectively with 34 Kg/h and 18 Kg/h. The productivity gradually increased from 30 Kg/h to 52 Kg/h in autumn to spring in sandy area. Summer gave only 1 Kg/h biomass. The forbs biomass on cultivated sites increased from 50 Kg/h, 60 Kg/h and 90 Kg/h respectively in autumn, winter and spring. While in rest of the stands i.e. foot hill and dry land yielded not more than 6 Kg/h in all the season (Table 23).

In the present study the total herbaceous productivity during spring was high. It was 869 Kg/h followed by autumn with 769 kg/h. it was due to rain in autumn and spring. The productivity was respectively 408 and 291 Kg/h in winter and summer. This is true that herbage productivity, besides other factor also related to the annual rainfall in the area (Jasra & Johnson, 2000). Similarly, Katung (2007) reported that primary productivity was higher in wet season than in dry and winter season in Nigeria. Same trend was observed in the present case as there was a decline in herbage production

during winter and summer season. In winter due to severe cold and in summer due to extreme hot, most of the plants were in dormant stage.

B. Productivity by shrubs

During autumn *Suaeda fruticosa* produced the maximum shoot biomass of 3805 Kg/h followed by *Tamarix dioica* 3600 Kg/h. *Prosopis cineraria* gave 3419 Kg/h and *Salvadora oleoides* produced 2765 Kg/h biomass. *Salsola foetida*, *Withania coagulans*, *Capparis decidua*, *Periploca aphylla* and *Zizyphus nummularia*, respectively produced 1875 Kg/h, 1252 Kg/h, 1021 Kg/h, 56 Kg/h and 1044 Kg/h, while *Atriplex griffithii*, *Calotropis procera* and *Prosopis juliflora* produced 780 Kg/h, 276 Kg/h and 220 Kg/h respectively. The remaining species were less productive as they could not yield more than 150 Kg/h biomass (Table 24). The total productivity for shrubs was 87546 Kg/h. based on habitats the productivity was highest (35141 Kg/h) in waterlogged area followed by foothill (21155 Kg/h). Cultivated land was next in biomass production (17452 Kg/h). Dry land, sandy and wet habitats respectively provided 8620 Kg/h, 3181 Kg/h and 1997 Kg/h of biomass. Due to water logged and saline condition *Salsola* and *Suaeda* are growing well which possibly yielded high. (Farooq *et al*., 2003) reported that rangelands are the largest natural resources which contributed both in grasses as well as shrub biomass of various plains of Pakistan but need to convert them into sown pasture. Our findings agree with them that local vegetation has converted into non palatable or less palatable plants which need management to improve the range productivity. White clover can easily be grown in both hilly areas and plains which would sustain a high level of pasture production (Abbasi & Khan, 2004; Kiyani, 2008).

It was observed that highest biomass (3600 Kg/h) was produced in waterlogged sites, which was followed by foot hill 2565 Kg/h. Rest of the sites were less productive. *Tamarix dioica* produced 3050 Kg/h followed by *Prosopis cineraria* 2726 Kg/h during winter. *Suaeda fruticosa*, *Salvadora oleoides* and *Salsola foetida* had 2550 Kg/h, 2545 Kg/h and 1258 Kg/h biomass, respectively. The biomass of *Atriplex grifithii*, *Zizyphus nummularia*, *Periploca aphylla*, *and Withania coagulans* ranged from 660 to 1069 Kg/h. The remaining species *Abutilon bidentatum*, *Aerva javanica*, *Ficus carica* and *Colligonum polygonoides* yielded less than 250 Kg/h (Table 24).

Among various habitats the highest biomass (3050 Kg/h) was obtained from water logged areas, which was followed by cultivated land (1005 Kg/h). During spring the highest biomass (5091 Kg/h) was recorded for *Tamarix dioica*, which was followed by *Prosopis cineraria* (3521 Kg/h). *Suaeda fruticosa*, *Salvadora oleoides* and *Atriplex griffithi* respectively yielded 3234 Kg/h, 2620 Kg/h and 344 Kg/h. *Salsola foetida*, *Withania coagulans*, *Zizyphus nummularia* and *Peripolca aphylla* were the next in

biomass production with 1627 Kg/h, 1359 Kg/h, 1235 Kg/h and 1000 Kg/h respectively. The remaining species produced not more than 120 Kg/h biomass. Waterlogged areas also yielded the highest biomass 5091 Kg/h followed by cultivated land 1150 Kg/h (Table 24). During summer the highest biomass 5100 Kg/h was harvested from *Tamarix dioica* followed by *Suaeda fruticosa* (4654 Kg/h), *Prosopis cineraria* (3833 Kg/h), *Salsola foetida* (3560 Kg/h) and *Solvadora oleides* (2472 Kg/h).

Similarly, *Withania coagulans* (1284 Kg/h), *Zizyphus nummularia* (1215 Kg/h), *Capparis decidua* (1106 Kg/h), *Atriplex griffithi* and *Periploca aphylla* each with (1100 Kg/h) were the next high biomass producing plants. Whereas the remaining species had less than 250 Kg/h dry biomass. During summer water logged areas had the highest biomass (5100 Kg/h), followed by cultivated land (3050 Kg/h) and foothill (1284 Kg/h).

In overall it was observed that in contrast to herbaceous highest biomass (26732 Kg/h) was produced during summer, which was followed by spring 22050 Kg/h. Autumn gave 21641 Kg/h and winter could give the lowest biomass of 17123 Kg/h (Table 25). The highest contribution was made by *Prosopis cineraria* followed by *Salsola foetida*. Hussain & Durrani (2007) stated that the months of summer were most productive in terms of grasses and shrub biomass in Harboi rangelands. This is in line with our observation where summer was the peak for shrub productivity. Osem *et al*. (2002) stated that above ground biomass in semi arid range land in Israel was decreased for palatable species but increased for rarely palatable and non palatable species. These findings are in agreement with the present case where the biomass of *Prosopis* and *Salsola* gave the highest productivity. *Atriplex grifithii*, *Zizyphus nummularia*, *Periploca aphylla*, *Withania coagulans* was next in order for productivity. Similar observations were made by Perkins & Keith (2003) who stated that defoliation by browsing significantly reduced shrub and grass biomass. Kumar *et al*. (2011) stated that biomass of vegetation generally increased with the age of plants in Rajistan India. In our case generally the biomass was less due to immature vegetation which satisfied the present report. Similar results that browsing totally altered the biomass of the vegetation reported by Rosenschein *et al*. (1999) and Hussain & Durrani (2007) which is in accordance with the present findings.

Table 21. Palatability, part used, condition and animal preferences of forage plants in rangelands of District Tank.

S. No	Species	Palatability classes						Part used			Condition			Livestock			
		Np	P	H	M	L	R	W	L	I	F	D	B	C	G	S	K
	A. Trees																
1.	*Acacia modesta* Wall.	-	+	+	-	-	-	-	+	-	+	-	-	-	+	-	+
2.	*Acacia nilotica* ssp. *nilotica* (L.) Wild. ex Delile	-	+	+	-	-	-	-	+		+	-	-	-	+	+	+
3.	*Dalbergia sissoo* Roxb.	-	+	-	-	-	+	-	+	-	+	-	-	-	+	+	
4.	*Eucalyptus globulus* Labill.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	*Morus alba* L.	-	+	+	-	-	-	-	+	-	+	-	-	-	+	+	-
6.	*Morus nigra* L.	-	+	+	-	-	-	-	+	-	+	-	-	-	+	+	-
7.	*Phoenix dactylifera* L.	-	+	-	-	-	+	-	+	-	+	-	-	-	+	+	-
8.	*Prosopis farcta* (Banks & Sol.) Macbride.	-	+	+	-	-	-	-	+	-	+	-	-	-	+	-	+
9.	*Tamarix aphylla* (L.) Karst	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	+
10.	*Zizyphus mauritiana* Lam.	-	+	+	-	-	-	-	+	-	+	-	-	-	+	-	+
	A. Shrubs																
11.	*Abutilon bidentatum* Hochst.ex A. Rich.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	-	+	-	-	-	+	-	+	-	-	+	-	-	+	-	+
13.	*Aerva lanata* (L.) Juss. ex Schultes	-	+	-	-	-	+	-	+	-	-	+	-	-	+	-	+
14.	*Atriplex griffithii* Moq.	-	+	-	-	+	-	-	+	-	-	-	+	-	+	-	+

15.	*Calligonum polygonoides* L.	-	+	-	+	-	-	-	+	-	+	-	-	-	-	-	+
16.	*Calotropis procera subsp. hamiltonii* (Wight) Ali	-	+	-	-	+	-	-	+	-	-	+	-	-	+	+	-
17.	*Capparis decidua* (Forssk.) Edgew.	-	+	+	-	-	-	+	-	-	+	-	-	-	+	-	+
18.	*Cassia senna* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.	*Celtis eriocarpa* Decne.	-	+	-	+	-	-	-	+	-	-	-	+	-	+	+	-
20.	*Crotolaria burhia* Buch.-Ham. ex Benth.	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
21.	*Dodonaea viscosa* (L.) Jacq.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22.	*Ficus carica* L.	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
23.	*Haloxylon multiflorum* (Moq.) Bunge.ex Boiss.	-	+	-	-	+	-	+	-	-	+	-	-	-	+	-	+
24.	*Kochia indica* Wight	-	+	-	-	+	-	-	+	-	-	+	-	-	-		+
25.	*Melia azedarach* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26.	*Nerium indicum* Mill.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27.	*Parkinsonia aculeata* L.	-	+	-	-	-	+	-	+	-	-	+	-	-	-	-	+
28.	*Periploca aphylla* Decne.	-	+	-	-	-	+	+	-	-	+	-	-	-	+	-	+
29.	*Periploca calophylla* (Wight) Falc.	-	+	-	-	-	+	+	-	-	+	-	-	+	-	-	+
30.	*Prosopis cineraria* (L.) Druce	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	+
31.	*Prosopis juliflora* Swartz	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	+
32.	*Rhazya stricta* Decne.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33.	*Salsola foetida* Del.ex Spreng.	-	+	-	-	-	+	+	-	-	-	+	-	-	-	-	+
34.	*Salvadora oleoides* Decne.	-	+	-	-	+	-	-	+	-	+	-	-	-	-	-	+

35.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	-	+	-	+	-	-	+	-	-	-	-	+	-	-	-	+
36.	*Tamarix dioica* Roxb. ex Roth.	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	+
37.	*Vitex negundo* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38.	*Withania coagulans* (Stocks) Dunal	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39.	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	-	+	+	-	-	-	+	-	-	+	-	-	+	+	+	+
	C. Herbs																
40.	*Achyranthes aspera* L.	-	+	-	-	+	-	-	+	-	+	-	-	+	-	+	-
41.	*Alhagi maurorum* Medic.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42.	*Allium cepa* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43.	*Allium sativum* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44.	*Amaranthus graecizans* L.	-	+	-	-	+	-	+	-	-	-	+	-	+	-	-	+
45.	*Amaranthus spinosus* L.	-	+	-	-	+	-	+	-	-	-	+	-	+	-	-	+
46.	*Amaranthus viridis* L.	-	+	-	+	-	-	-	+	-	-	+	-	+	-	-	+
47.	*Anagallis arvensis* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48.	*Anethum graveolens* L.	-	+	-	+	-	-	+	-	-	-	+	-	-	+	+	-
49.	*Aristida adscensionis* L.	-	+	-	+	-	-	+	-	-	-	+	-	+	-	+	-
50.	*Aristida cyanantha* Nees ex Steud.	-	+	-	+	-	-	+	-	-	-	+	-	-	-	+	+
51.	*Aristida mutabilis* Trin. & Rupr.	-	+	-	+	-	-	+	-	-	-	+	-	-	-	+	+
52.	*Aristida triticoides* Henr.	-	+	+	-	-	-	+	-	-	-	+	-	-	-	+	-
53.	*Arnebia hispidissima* (Lehm.) A. DC.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

54.	*Arnebia miniata* Bunge	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55.	*Asphodelus tenuifolius* Cav.	-	+	-	-	+	-	+	-	-	-	+	-	-	+	-	-
56.	*Astragalus tribuloides* Delile	-	+	-	-	-	+	+	-	-	-	-	+	-	+	-	-
57.	*Astragalus amherstianus* Bth.ex. Royle	-	+	-	-	+	-	+	-	-	+	-	-	-	+	-	+
58.	*Avena sativa* L.	-	+	+	-	-	-	+	-	-	+	-	-	-	+	+	-
59.	*Boerhavia diffusa* L.	-	+	-	+	-	-	-	+	-	-	-	+	-	+	-	-
60.	*Boerhavia procumbens* Banks ex Roxb.	-	+	-	+	-	-	+	-	-	+	-	-	-	-	+	-
61.	*Brassica rapa subsp. campestris* (L.) Clapham	-	+	+	-	-	-	-	+	-	-	+	-	-	-	+	-
62.	*Campanula benthamii* Wall. ex Kitamura	-	+	-	-	-	+	-	+	-	-	+	-	-	+	+	-
63.	*Campanula sulaimanii* E. Nasir	-	+	-	-	-	+	-	+	-	-	+	-	-	+	-	-
64.	*Cenchrus biflorus* Roxb.	-	+	-	+	-	-	+	-	-	+	-	-	-	-	+	-
65.	*Cenchrus ciliaris* L.	-	+	-	-	-	+	+	-	-	+	-	-	+	-	-	-
66.	*Centaurea iberica* Trevir. ex Spreng.	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
67.	*Centaurea moschata* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68.	*Centaurium pulchellum* (Sw.) Druce	-	+	-	+	-	-	+	-	-	+	-	-	-	-	+	-
69.	*Centaurium spicatum* (L.) Fritsch	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70.	*Chenopodium album* L.	-	+	-	+	-	-	+	-	-	-	-	+	-	-	+	-
71.	*Chenopodium ambrosioides* L.	-	+	-	+	-	-	+	-	-	-	-	+	-	-	+	-
72.	*Chenopodium murale* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

73.	*Chenopodium nepalense* Colla	-	+	-	-	-	+	-	+	-	-	-	+	-	+	-	-
74.	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75.	*Chrozophora tinctoria* (L.) Raf.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
76.	*Cicer aeritenum* L.	-	+	+	-	-	-	+	-	-	-	-	+	+	+	+	+
77.	*Citrullus colocynthis* (L.) Schrad.	-	+	-	+	-	-	-	+	-	-	+	-	-	-	+	-
78.	*Cleome brachycarpa* Vahl ex DC.	-	+	-	-	+	-	-	+	-	-	-	+	-	-	+	-
79.	*Convolvulus prostratus* Forssk.	-	+	-	-	-	+	-	+	-	+	-	-	-	-	+	-
80.	*Convolvulus arvensis* L.	-	+	+	-	-	-	+	-	-	+	-	-	-	-	+	-
81.	*Convolvulus microphyllus* Sieb. ex Spreng.	-	+	-	+	-	-	-	+	-	+	-	-	-	-	+	-
82.	*Conyza canadensis* (L.) Cronquist	-	+	-	-	-	+	+	-	-	+	-	-	-	+	-	-
83.	*Corchorus aestuans* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
84.	*Coronopus didymus* (L.) Smith	-	+	-	-	+	-	+	-	-	+	-	-	-	-	+	-
85.	*Cousinia minuta* Boiss.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
86.	*Crambe cordifolia* Steven	-	+	-	-	-	+	-	+	-	-	-	+	-	-	+	-
87.	*Cuscuta reflexa* Roxb.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
88.	*Cyamopsis tetragonoloba* (L.) Taubert	-	+	-	-	-	+	-	+	-	-	-	+	-	-	+	-
89.	*Cymbopogon jwarancusa* (Jones) Schult.	-	+	+	-	+	-	+	-	-	-	-	+	-	+	+	-
90.	*Cynodon dactylon* (L.) Pers.	-	+	+	-	-	-	+	-	-	+	-	-	+	+	+	-
91.	*Cynoglossum lanceolatum* Forssk.	-	+	-	-	+	-	+	-	-	-	-	+	-	+	+	-

92.	*Cyprus difformis* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
93.	*Cyprus rotundus* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
94.	*Dactyloctenium aegyptium* (L.) Willd.	-	+	-	-	+	-	-	-	+	-	-	+	-	+	-	-	-
95.	*Datura alba* Nees	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
96.	*Desmostachya bipinnata* (L.) Stapf.	-	+	-	-	-	+	-	+	-	-	+	-	+	-	-	-	-
97.	*Dichanthium annulatum* (Forssk.) Stapf.	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-	-
98.	*Echinochloa colona* (L.) Link.	-	+	-	-	-	+	-	+	-	-	+	-	-	+	+	-	-
99.	*Echinochloa crus-galli* (L.) Beauv.	-	+	-	-	-	+	-	+	-	-	+	-	-	+	-	-	-
100.	*Eclipta alba* (L.) Hassk.	-	+	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-
101.	*Emex australis* Steinh.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
102.	*Emex spinosus* (L.) Campd.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
103.	*Equisetum arvense* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
104.	*Eragrostis cilianensis* (All.) Lut. ex F.T.	-	+	-	-	-	+	-	-	+	-	-	+	-	+	+	-	-
105.	*Eragrostis minor* Host	-	+	+	-	-	-	+	-	-	+	-	-	-	+	+	-	-
106.	*Euphorbia dracunculoides* Lam.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
107.	*Euphorbia granulata* Forssk.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
108.	*Euphorbia helioscopia* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
109.	*Euphorbia prostrata* Ait.	-	+	-	-	-	+	+	-	-	+	-	-	+	-	-	-	-
110.	*Euphorbia thymefolia* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
111.	*Fagonia indica* var.	-	+	+	-	-	-	+	-	-	+	-	-	-	-	-	-	+

	schweinfurthii Hadidi																
112.	*Farsetia hamiltonii* Royle	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
113.	*Farsetia ramosissima* Hochst. ex Boiss.	-	+	-	-	+	-	-	+	-	-	+	-	-	-	+	-
114.	*Filago arenaria* (Smoljan.) Chrtek & Holub	-	+	-	-	-	+	+	-	-	-	+	-	-	-	+	-
115.	*Fumaria indica* (Hausskn.) Pugsley	-	+	-	+	-	-	-	+	+	-	-	-	-	+	-	-
116.	*Gastrocotyle hispida* (Forssk.) Bunge	-	+	-	-	+	-	+	-	-	-	+	-	-	-	-	+
117.	*Halostachys belangerana* (Moq.) Botsch	-	+	-	-	-	+	+	-	-	+	-	-	-	-	-	+
118.	*Heliotropium elipticum* Ledeb.	-	+	-	-	+	-	-	+	-	-	+	-	+	-	-	-
119.	*Heliotropium europaeum* L.	-	+	-	-	+	-	+	-	-	+	-	-	-	-	+	-
120.	*Heliotropium ovalifolium* Forssk.	-	+	-	-	+	-	-	+	-	-	+	-	+	-	-	-
121.	*Hyoscyamus squarrosus* Griff.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
122.	*Hypecoum pendulum* L.	-	+	-	-	+	-	-	+	-	-	-	+	-	-	+	-
123.	*Hypericum perforatum* L.	-	+	-	-	+	-	+	-	-	+	-	-	-	-	-	+
124.	*Imperata cylindrica* L.	-	+	-	+	-	-	-	-	-	+	-	+	-	+	-	-
125.	*Juncus bufonius* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
126.	*Juncus inflexus* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
127.	*Lathyrus aphaca* L.	-	+	+	-	-	-	+	-	-	+	-	-	-	-	+	-
128.	*Lathyrus sativus* L.	-	+	-	+	-	-	-	+	-	-	+	-	+	-	-	-
129.	*Launaea nudicaulis* (L.) Hook.f.	-	+	-	-	+	-	+	-	-	-	-	+	-	+	-	-
130.	*Malcolmia africana* (L.) R. Br	-	+	-	-	+	-	+	-	-	-	-	+	-	-	+	-

131.	*Malcolmia scorpioides* (Bunge) Boiss.	-	+	-	-	-	+	-	+	-	-	+	-	-	-	+	-
132.	*Malva neglecta* Wallr.	-	+	-	+	-	-	+	-	-	+	-	-	-	-	+	-
133.	*Malva parviflora* L.	-	+	-	+	-	-	+	-	-	+	-	-	-	-	+	-
134.	*Malvastrum coromandelianum* (L.) Garcke	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	-
135.	*Matthiola incana* (L.) R. Br.	-	+	-	-	-	+	-	+	-	-	+	-	-	+	-	-
136.	*Medicago minima* (L.) Grufb	-	+	+	-	-	-	+	-	-	-	-	+	-	-	+	-
137.	*Medicago polymorpha* L.	-	+	+	-	-	-	+	-	-	-	-	+	+	+	+	-
138.	*Medicago laciniata* (L.) Mill.	-	+	-	+	-	-	+	-	-	+	-	-	+	-	+	-
139.	*Melilotus indica* (L.) All.	-	+	+	-	-	-	+	-	-	-	-	+	-	-	+	-
140.	*Melilotus alba* Desr.	-	+	-	+	-	-	-	+	-	-	-	+	+	-	+	-
141.	*Mentha longifolia* (L.) L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
142.	*Mentha spicata* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
143.	*Ochthochloa compressa* (Forssk.) Hilu	-	+	-	-	-	+	-	+	-	-	-	+	-	+	-	-
144.	*Ocimum basilicum* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
145.	*Oligomeris linifolia* (Vahl.) Macbride	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
146.	*Oryza sativa* L.	-	+	+	-	-	-	+	-	-	-	-	+	+	+	+	+
147.	*Oxalis corniculata* L.	-	+	-	-	-	+	-	+	-	-	-	+	-	-	+	-
148.	*Oxystelma esculentum* (L. f.) R. Brown	-	+	-	-	+	-	+	-	-	+	-	-	+	-	-	-
149.	*Panicum antidotale* Retz.	-	+	-	+	-	-	+	-	-	-	-	+	-	+	-	-
150.	*Panicum capillare* L.	-	+	-	+	-	-	+	-	-	-	-	+	-	+	-	-

151.	*Parkinsonia aculeata* L.	-	+	-	-	-	+	+	-	-	+	-	-	-	-	-	+
152.	*Peganum harmala* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
153.	*Phalaris aquatica* L.	-	+	-	+	-	-	+	-	-	-	+	-	-	+	-	-
154.	*Phragmites karka* (Retz.) Trin. ex Steud.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
155.	*Plantago ciliata ssp. lanata* (Boiss.) Rech. f.	-	+	-	-	+	-	+	-	-	-	-	+	-	-	+	-
156.	*Plantago lanceolata* L.	-	+	-	-	+	-	+	-	-	-	-	+	-	-	+	-
157.	*Plantago major* L.	-	+	-	-	+	-	+	-	-	-	-	+	-	-	+	-
158.	*Poa annua* L.	-	+	+	-	-	-	+	-	-	-	-	+	-	-	+	-
159.	*Poa infirma* H. B. K.	-	+	+	-	-	-	+	-	-	-	-	+	-	-	+	-
160.	*Polygonum patulum* M. Bieb.	+	-	-	-	-	-	-	-	-	-	-		-	-	-	-
161.	*Polygonum plebejum* R. Br.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
162.	*Polypogan monspeliensis* (L.) Desf.	-	+	+	-	-	-	-	+	-	-	-	+	+	-	-	-
163.	*Portulaca quadrifida* L.	-	+	-	-	-	+	+	-	-	+	-	-	-	-	-	+
164.	*Psammogeton biternatum* Edgew.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
165.	*Pulicaria crispa* (Forssk.) B.H.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
166.	*Ranunculus muricatus* L.	-	+	-	-	+	-	-	-	+	-	-	+	-	-	+	-
167.	*Ranunculus sceleratus* L.	-	+	-	-	+	-	+	-	-	-	+	-	+	-	-	-
168.	*Reseda odorata* L	-	+	-	-	+	-	+	-	-	-	+	-	+	-	-	-
169.	*Ricinus communis* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
170.	*Rumex dentatus* L.	-	+	-	-	+		+			+			+			
171.	*Rumex obtisifolius* L.	-	+	-	-	+	-	+	-	-	+	-	-	+	-	-	-

172.	*Saccharum bengalense* Retz.	-	+	+	-	-	-	-	+	-	-	-	+	+	-	-	-
173.	*Saccharum munja* Roxb.	-	+	-	-	+	-	-	+	-	-	+	-	+	-	-	-
174.	*Saccharum spontaneum* L.	-	+	-	-	-	+	+	+	-	-	-	-	+	-	+	-
175.	*Schismus barbatus* (L.) Thell.	-	+	-	+	-	-	+	-	-	-	-	+	-	-	+	-
176.	*Sclerochloa dura* (L.) P. Beauv.	-	+	-	-	-	+	-	-	+	-	-	+	-	-	+	-
177.	*Setaria verticillata* (L.) P. Beauv.	-	+	-	+	-	-	+	-	-	-	-	+	-	-	+	-
178.	*Silene conoidea* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
179.	*Sisymbrium irio* L.	-	+	-	+	-	-	-	+	-	-	+	-	-	-	+	-
180.	*Solanum nigrum* L.	-	+	-	+	-	-	+	-	-	-	-	+	+	-	+	-
181.	*Solanum surattense* Burm. f.	-	+	-	+	-	-	+	-	-	-	-	+	-	-	+	-
182.	*Sonchus asper* (L.) Hill	-	+	-	-	-	+	+	-	-	+	-	-	-	+	-	+
183.	*Sonchus oleraceus* L.	-	+	-	-	-	+	+	-	-	+	-	-	-	-	-	+
184.	*Spergula arvensis* L.	-	+	-	-	+	-	-	-	+	-	+	-	-	+	-	-
185.	*Spergularia marina* (L.) Griseb.	-	+	-	-	+	-	-	-	+	-	+	-	-	+	-	-
186.	*Taraxacum officinale* F. H. Wigg.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
187.	*Torilis japonica* (Houtt.) DC.	-	+	-	-	+	-	+	-	-	-	-	+	-	+	-	-
188.	*Trianthema portulacastrum* L.	-	+	-	-	-	+	+	-	-	-	-	+	-	+	+	-
189.	*Tribulus terrestris* L.	-	+	+	-	-	-	+	-	-	+	-	-	-	-	+	-
190.	*Tribulus pentandrus* Forssk.	-	+	-	+	-	-	+	-	-	-	+	-	+	-	+	-
191.	*Tricholepis chaetolepis* (Boiss.) Rech. f.	-	+	-	+	-	-	+	-	-	-	-	+	-	+	-	-
192.	*Trifolium alexandrianum* L.	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-
193.	*Trifolium repense* L.	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-

194.	*Triticum aestivum* L.	-	+	+	-	-	-	+	-	-	-	-	+	+	+	+	+
195.	*Typha latifolia* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
196.	*Typha minima* Funck ex Hoppe	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197.	*Urtica pilulifera* L.	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	-
198.	*Veronica aqutica* Bern.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
199.	*Veronica biloba* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
200.	*Vicia faba* L.	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
201.	*Vicia tetrasperma* (L.) Schreber	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-
202.	*Viola stocksii* Boiss.	-	+	-	-	-	+	-	+	-	-	+	-	-	-	+	-
203.	*Withania somnifera* (L.) Dunal	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
204.	*Xanthium strumarium* L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
205.	*Zea mays* L.	+	-	+	-	-	-	+	-	-	-	-	+	+	+	+	+
Total		56.0	149	33.0	33.0	42.0	43.0	82.0	61.0	8.0	54.0	44.0	51.0	36.0	66.0	72.0	40.0
% age		27.3	72.7	16.1	16.1	20.4	20.9	40.0	29.7	3.9	36.2	29.5	34.3	17.5	32.1	35.1	19.5

Key: Np = Non palatable; P = Palatable; H = Highly palatable; M= Mostly palatable

L = Less palatable; R = Rarely palatable; W = Whole plant; L = leaves

I = Inflorescence; F = Fresh; D = Dry; B = Both; C = Cow; G = Goat

S = Sheep and K = Camel

Table 22. Seasonal availability of fodder species in rangeland of District Tank

S. No.	Seasonality	No of species	% ages
1.	Autumn	76	19.4
2.	Winter	78	19.9
3.	Spring	138	35.2
4.	Summer	100	25.5

Table 23. Seasonal variation in the biomass (Kg/h) of herbaceous vegetation in different habitats of District Tank Pakistan

Season	Communities/ Stands												Total
	Sandy		Cultivated land		Dry land		Water logged		Water courses		Foot hills		
	G	F	G	F	G	F	G	F	G	F	G	F	
Autumn	74	45	100	50	15	4	30	180	110	95	63	3	769
Winter	50	30	120	60	5	-	5	10	93	34	-	-	408
Spring	100	52	150	90	18	6	36	120	123	95	73	6	869
Summer	90	1	60	5	16	5	20	10	30	18	33	3	291
Total	314	128	430	205	54	15	91	320	356	242	169	12	2336
	442		635		69		411		598		181		

Table 24. Seasonal variation of biomass of shrubs (Kg/h) in different habitats of District Tank, Pakistan

No	Species	Seasons	Habitats						
			Sandy	Cultivated	Dry land	Water logged	Water courses	Foot hills	Total
1	*Prosopis cineraria* (L.) Druce	Autumn	237	-	666	2100	166	250	3419
		Winter	198	-	272	1900	140	216	2726
		Spring	205	-	623	2300	176	217	3521
		Summer	243	-	620	2500	205	265	3833
2	*Prosopis farcta* (Banks & Sol.) Macbride	Autumn	-	-	160	-	-	-	160
		Winter	-	-	115	-	-	-	115
		Spring	-	-	116	-	-	-	116
		Summer	-	-	180	-	-	-	180
3	*Capparis decidua* (Forssk.) Edgew.	Autumn	205	-	660	-	-	156	1021
		Winter	196	-	250	-	-	119	565
		Spring	215	-	505	-	-	144	864
		Summer	261	-	700	-	-	145	1106
4	*Salsola foetida* Del.ex Spreng.	Autumn	-	1505	250	120	-	-	1875
		Winter	-	1005	153	100	-	-	1258
		Spring	-	1150	257	220	-	-	1627
		Summer	-	3050	280	230	-	-	3560
5	*Suaeda fruticosa* Forssk. ex J. F.Gmelin	Autumn	-	1305	500	2000	-	-	3805
		Winter	-	600	350	1600	-	-	2550
		Spring	-	700	434	2100	-	-	3234

		Summer	-	1650	604	2400	-	-	4654
6	*Atriplex griffithii* Moq.	Autumn	-	700	80	-	-	-	780
		Winter	-	600	60	-	-	-	660
		Spring	-	224	120	-	-	-	344
		Summer	-	1000	100	-	-	-	1100
7	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	Autumn	146	-	130	-	-	-	276
		Winter	130	-	100	-	-	-	230
		Spring	150	-	147	-	-	-	297
		Summer	169	-	188	-	-	-	357
8	*Salvadora oleoides* Decne.	Autumn	200	-	-	-	-	2565	2765
		Winter	195	-	-	-	-	2350	2545
		Spring	215	-	-	-	-	2405	2620
		Summer	216	-	-	-	-	2256	2472
9	*Zizyphus nummularia* (Burm.f.) Wight & Arn.	Autumn	-	900	-	-	-	144	1044
		Winter	-	857	-	-	-	137	994
		Spring	-	1106	-	-	-	129	1235
		Summer	-	1100	-	-	-	115	1215
10	*Tamarix dioica* Roxb. ex Roth.	Autumn			-	3600	-	-	3600
		Winter	-	-	-	3050	-	-	3050
		Spring	-	-	-	5091	-	-	5091
		Summer	-	-	-	5100	-	-	5100
11	*Vitex negundo* L.	Autumn	-	-	-	150	-	-	150
		Winter	-	-	-	130	-	-	130

		Spring	-	-	-	200	-	-	200
		Summer	-	-	-	250	-	-	250
12	*Prosopis juliflora* Swartz	Autumn	-	-	-	-	220	-	220
		Winter	-	-	-	-	160	-	160
		Spring	-	-	-	-	270	-	270
		Summer	-	-	-	-	240	-	240
13	*Abutilon bidentatum* Hochst. ex A. Rich.	Autumn	-	-	-		50	-	50
		Winter	-	-	-	-	20	-	20
		Spring	-	-		-	90	-	90
		Summer	-	-	-	-	50	-	50
14	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schult.	Autumn	-	-	-	-	60	20	80
		Winter	-	-	-	-	30	15	45
		Spring	-	-	-	-	50	15	65
		Summer	-	-	-	-	70	22	92
15	*Periploca aphylla* Decne.	Autumn	-	-	-	-	-	1053	1053
		Winter	-	-	-	-	-	930	930
		Spring	-	-	-	-	-	1000	1000
		Summer	-	-	-	-	-	1100	1100
16	*Periploca calophylla* (Wight) Falc.	Autumn	-	-	-	-	-	56	56
		Winter	-	-	-	-	-	50	50
		Spring	-	-	-	-	-	65	65
		Summer	-	-	-	-	-	80	80

17	*Withania coagulans* (Stocks) Dunal	Autumn	-	-	-	-	-	1252	1252
		Winter	-	-	-	-	-	1069	1069
		Spring	-	-	-	-	-	1359	1359
		Summer	-	-	-	-	-	1284	1284
18	*Ficus carica* L.	Autumn	-	-	-	-		10	10
		Winter	-	-	-	-	-	10	10
		Spring	-	-	-	-	-	25	25
		Summer	-	-	-	-	-	29	29
19	*Celtis eriocarpa* Decne.	Autumn	-	-	-	-	-	10	10
		Winter	-	-	-	-	-	9	9
		Spring	-	-	-	-	-	11	11
		Summer	-	-	-	-	-	14	14
20	*Calligonum polygonoides* L.	Autumn	-	-	-	-	-	15	15
		Winter	-	-	-	-	-	7	7
		Spring	-	-	-	-	-	16	16
		Summer	-	-	-	-	-	16	16
Total biomass			3181	17452	8620	35141	1997	21155	87546

Table 25. The overall seasonal variation in biomass productivity of shrub in different habitats of District Tank, Pakistan.

Season	Sandy	Cultivated land	Dry land	Water-logged	Water courses	Foot hill	Total
Autumn	788	4410	2446	7970	496	5531	21641
Winter	719	3062	1300	6780	350	4912	17123
Spring	785	3180	2202	9911	586	5386	22050
Summer	889	6800	2672	10480	565	5326	26732
Total	3181	17452	8620	35141	1997	21155	87546
Ave	795.25	4363	2155	8785.25	499.25	5288.75	21886.5

CHEMICAL EVALUATION OF PLANTS

CHEMICAL EVALUATION OF PLANTS

CHEMICAL EVALUATION OF SOME PLANTS

Minerals

A. Macronutrients

Macronutrients besides constituents of body fluids as electrolytes protect and maintain the structural components of the body organs and tissues. Minerals play a vital role in growth, reproduction, health and proper functioning of the animal's body. The rangelands support about 30 million herds of livestock, which play a key role in Pakistan's annual export income (Anon., 2006).

1. Calcium (Ca)

Calcium, an essential part of the plant cell wall, provides support, rigidity and strength. Ca has been recognized as an essential element in animal nutrition for at least 100 years. Quantitatively, the participation of Ca in the formation of bones is its important function. The present data showed no significant differences in calcium contents between herbs and woody plants and between different phenological stages (Table 27). The mean value among herbs varied in between 4.22% (*Avena sativa*) to 15.21% (*Trifolium alexandrianum*). Among woody plants, Ca contents varied from 3.8% (*Suaeda fruticosa*) to 20.88% (*Zizyphus mauritiana*) (Table 26). Generally, Ca contents increased with maturity of plants in herbs. The conclusions of Seiler & Campbell (2004) were similar to our findings as adequate Ca contents were found in investigated forages plants during flowering stages than young stages. Similarly, there is an agreement between our findings and those of Ashraf *et al*. (2005) and Khan *et al*. (2005), who also reported significant increased Ca concentration in mature forage plants. While, the trend was reversed in woody plants as Ca contents decreased with advancing age of plants. This is also in line with those of Hussain & Durrani (2008), who stated that certain elements decreased with the maturity of forage plants.

2. Potassium (K)

Potassium is an essential nutrient that activates many enzyme systems. Its deficiency adversely affects the plant growth and metabolism (Rahim *et al*., 2008). Physiological functions of livestock requires at least 0.5 ppm potassium (Anon., 1985). The herbs generally had higher K contents than woody forages (Table 26). This is in agreement with those of Hussain & Durrani (2008) and Akhtar *et al*. (2007) who reported

that herbaceous plants and grasses are nutritionally rich at early growing stages. Among herbs, it was highest (4.13%) in *Convolvulus arvensis*, which decreased to minimum (2.58%) in *Avena sativa*. It varied from 0.61% (*Withania coagulans*) to 1.64% (*Salsola foetida*) among woody plants. The highest K contents were recorded for *Avena sativa*, *Tribulus terrestris* and *Trifolium alexandrianum* at pre-reproductive stages and for *Convulvulus arvensis* and *Salsola foetida* at reproductive stages. Similar report was made by Ahmad *et al*. (2008c) who stated that different plants parts and phenological stages varied in K concentration. This is also in accordance with our study. Statistical analysis showed highly significant differences between herbs and woody species and among various growth stages (Table 26). Legumes and grasses had more K values as compared to shrub and trees in range forages (Abbasi *et al*., 2009) which are also in line with our results.

3. Sodium (Na)

Sodium is necessary for regulation of blood and body fluids, heart activity and certain metabolic functions such as regulation of blood volume and blood pressure, improves the transmission of nerve impulses and used to help regulate the acid/base balance in the body. In the present tested plants, there were significant differences between herbs and woody species at only reproductive stage (Table 27). Among the herbs, the Na contents fluctuated from 0.7% (*Convolvulus arvensis*) to 0.41% (*Trifolium alexandrianum*). In woody plants, the range was from 0.11% (*Withania coagulans*) to 1.25% (*Salsola foetida*) (Table 26). Except, *Convolvulus arvensis*, Na contents in other herbs reduced toward maturity of the plant. Ahmad *et al*. (2008b) reported that most of the forage plants from Punjab had sufficient Na contents but showing variation in its concentration in different parts and phenological stages. This argument supports our findings. Highest Na contents among woody plants were generally recorded at reproductive stages, except *Suaeda fruticosa*, and *Calotropis procera*. Similar results were reported by Hussain & Durrani (2008) from Harboi. These two species showed higher concentration at pre reproductive stages. *Withania coagulans* had exceptionally high Na contents at post reproductive stage (Table 26). Khan *et al*. (2006b, 2007) and Tiffany *et al*. (2000) reported deficiency of sodium in various forage plants from different

regions; therefore, our results are in line with them as this study also reports low contents in most of the cases.

4. Phosphorous (P)

Phosphorous is essential for strengthening the skeleton, teeth, improving blood plasma, assimilation of carbohydrates, fats protein synthesis and necessary for enzyme activation. Its deficiency causes poor growth and development of animals. Phosphorous is the most limiting mineral to productivity of grazing animals throughout the world because of low availability to range plants and loss through soil erosion (Vallentine, 1990; Holechek *et al*., 1998; Akhtar *et al*., 2007: Hussain & Durrani, 2008). Generally, high P concentration was observed at pre- reproductive stages in all the tested forage plants (Table 26). The work of Dave & Dave (2003) also supported our findings who stated that P level were adequate for animal early in the growing season and declined at maturity. The average P contents among herbs ranged in between 0.24% (*Avena sativa*) to 0.3% (*Convolvulus arvensis*). Animal require a minimum of 0.16% to 0.37% phosphorous (Anon., 1982, 1985). The present study shows that phosphorous contents of the tested plants were generally in the range of suggested limits. This showed that livestock grazing in District Tank might not face phosphorous deficiency during grazing period. However, our findings are in contradiction with those of Akhtar *et al*. (2007), who observed P deficiency in forage plants. While, on the other hand the present findings are in accordance with those of Hussain & Durrani (2008). Among woody plants, P shifted from 0.15% (*Acacia nilotica*) to 0.26% (*Prosopis cineraria*) (Table 26). No significant differences between and among herbs and woody and different phenological stages were seen (Table 27). This also agrees with the findings of Chaturvedi *et al*. (2006), who reported slight seasonal variations in P concentration in community rangelands.

5. Total Nitrogen (N)

Nitrogen is a significant nutritional element for plants. It is a major component of all amino acids, which are the building blocks of all proteins, including the enzymes, which control nearly all biological processes (Brady & Weil, 1999). The lowest (0.93%) and highest (2.05%) N contents were recorded in *Trifolium alexandrianum*, respectively at pre-reproductive and reproductive stages among herbaceous plants (Table 26). *Tribulus terrestris* and *Trifolium alexandrianum* had the highest N contents at

reproductive stage. This is in agreement with those of Abbasi *et al*. (2009) who recorded highest N contents in legumes than others. Increase or decrease in total nitrogen contents without any trend was observed at different phenological stages. Bignami *et al*. (2005) observed inconsistencies in leaf N contents during the growing seasons. The present findings agree with them because no regular trend for nitrogen contents was recorded in the investigated plants. It varied from 0.15% (*Zizyphus mauritiana*) to 1.95% (*Prosopis cineraria*) among woody plants (Table 26). *Zizyphus mauritiana* and *Withania coagulans* had highest nitrogen values at reproductive stage, and *Acacia nilotica*, *Suaeda fruticosa*, *Salsola foetida* and *Calotropis procera* showed high N concentration at post reproductive stage. *Prosopis cineraria* had high N contents at pre-reproductive stage. Statistical analysis indicated insignificant differences between and among herbs and woody plants (Table 27).

6. Magnecium (Mg)

Magnesium is one of the most vital mineral components of the cell which is a structural constituent of the skeletal system. As an enzyme activator, magnesium catalyses different enzyme reaction which take part in the ion transport in the nerve cell and in the maintenance of neuromuscular excitation both in human being and animal. About 0.05 % of the body mass consists of magnesium. Generally, a high trend of Mg contents was observed in woody plants than herbs, except *Prosopis cineraria* and *Acacia nilotica ssp. nilotica* which had lowest contents of 4.56 ppm and 5.16 ppm, respectively (Table 26). Among the herbs, the mean value ranged in between 16.55 (ppm) to 25.79 (ppm). The mean value varied in between 4.56 ppm (*Prosopis cineraria*) to 32.65 ppm (*Salsola foetida*) among woody species. Canali *et al*. (2005) also reported high concentration of Mg in a number of forage plants. In *Convolvulus* and *Tribulus*, the Mg concentration was high at reproductive and post reproductive stages, respectively. *Avena sativa* and *Trifolium alexandrianum* exhibited the high Mg contents at reproductive stages. Kallah *et al*. (2000) observed that Mg contents were sufficient in the forages for ruminant production in tropics which satisfy the present findings. No significant differences in Mg contents were observed between herbs and woody species and among various stages (Table 27).

After determining the macronutrients in selected forage plants it is concluded that sufficient levels of macro-nutrients were present in the investigated forage plants. Therefore, there is no need to supplement macro-nutrient in feed to the ruminants of District Tank. However, these fodders are under stress and need sustainable utilization for the longevity of the rangelands. Even so, further study is needed to search out the grounds of poor health and biomass of the ruminants. It appears that nutrients alone could not be the only reason for poor health and productivity in this neglected part of Pakistan.

Table 26. Variation in macronutrient contents at various phenological stages of some forage plants of District Tank.

Species	Stage	Ca %	K %	Na %	P %	N %	Mg %
A. Herbs							
Convolvulus arvensis L.	Pre- Rep.	15.03	4.46	0.12	0.24	1.9	21.85
	Reproductive	7.3	4.49	0.04	0.3	1.88	15.95
	Post- Rep.	6.47	3.45	0.05	0.36	1.33	18.12
	Mean	**9.6**	**4.13**	**0.07**	**0.3**	**1.7**	**18.64**
Avena sativa L.	Pre- Rep.	6.31	4.85	0.3	0.31	1.36	21.63
	Reproductive	4.02	1.68	0.11	0.18	1.05	16.14
	Post- Rep.	2.35	1.23	0.08	0.23	1.04	11.89
	Mean	**4.22**	**2.58**	**0.16**	**0.24**	**1.15**	**16.55**
Tribulus terrestris L.	Pre- Rep.	13.63	4.66	0.54	0.3	2.01	29.7
	Reproductive	9.74	3.16	0.18	0.26	1.88	14.92
	Post- Rep.	10.53	3.19	0.23	0.28	1.89	32.76
	Mean	**11.3**	**3.67**	**0.31**	**0.28**	**1.92**	**25.79**
Trifolium alexandrianum L.	Pre- Rep.	13.01	4.09	1	0.27	0.93	16.1
	Reproductive	15.27	3.09	0.11	0.23	2.05	30.23
	Post- Rep.	17.35	3.3	0.13	0.26	1.55	13.77
	Mean	**15.21**	**3.49**	**0.41**	**0.25**	**1.51**	**20.03**
B. Woody plants							
Zizyphus mauritiana Lam.	Pre- Rep.	19.83	1	0.16	0.22	1.25	16.28
	Reproductive	22.95	0.99	0.22	0.17	1.3	21.28
	Post- Rep.	19.87	0.84	0.15	0.14	1.11	18.53
	Mean	**20.88**	**0.94**	**0.17**	**0.17**	**0.15**	**8.69**
Acacia nilotica ssp. *nilotica* (L.) Wild. ex Delile	Pre- Rep.	17.46	0.7	0.11	0.13	1.16	7.45
	Reproductive	18.67	1.27	0.23	0.16	1	7.95
	Post- Rep.	18.67	0.76	0.1	0.17	1.66	0.1
	Mean	**18.26**	**0.91**	**0.14**	**0.15**	**1.27**	**5.16**

Prosopis cineraria (L.) Druce	Pre- Rep.	9.8	1.38	0.15	0.32	2.11	6.4
	Reproductive	5.21	0.31	0.24	0.33	1.82	2.16
	Post- Rep.	3.19	1.59	0.17	0.14	1.94	5.13
	Mean	**6.06**	**1.09**	**0.18**	**0.26**	**1.95**	**4.56**
Suaeda fruticosa Forssk. ex J. F. Gmelin	Pre- Rep.	4.94	1.3	1.3	0.14	1.73	12.51
	Reproductive	3.25	1.41	0.99	0.3	1.37	25.08
	Post- Rep.	3.3	1.5	1.11	0.3	1.87	14.54
	Mean	**3.8**	**1.4**	**1.13**	**0.24**	**1.65**	**17.37**
Salsola foetida Del.ex Spreng.	Pre- Rep.	17.85	0.3	1.17	0.4	1.17	37.56
	Reproductive	11.93	2.98	1.44	0.13	1.16	30.7
	Post- Rep.	13.06	1.66	1.15	0.18	1.51	29.7
	Mean	**14.28**	**1.64**	**1.25**	**0.23**	**1.28**	**32.65**
Calotropis procera ssp. hamiltonii (Wight) Ali	Pre- Rep.	21.67	1.09	0.99	0.21	1.21	30.71
	Reproductive	14.27	0.45	0.77	0.1	1.02	23.43
	Post- Rep.	16.26	0.31	0.75	0.27	1.52	33.35
	Mean	**17.4**	**0.61**	**0.83**	**0.19**	**1.25**	**29.16**
Withania coagulans (Stocks) Dunal	Pre- Rep.	13.22	1.8	0.1	0.15	1.2	27.58
	Reproductive	11.71	0.4	0.09	0.16	1.56	43.82
	Post- Rep.	11.88	0.4	0.16	0.2	1.2	23.43
	Mean	**12.27**	**0.86**	**0.11**	**0.17**	**1.32**	**31.61**

Table 27. Statistical analysis of macronutrients (T-test) between herbs and woody forage plants of District Tank.

Pre- Rep		Reproductive		Post-Rep	
Herbs	Woody	Herbs	Woody	Herbs	Woody
Ca					
15.03	19.83	7.3	23.95	6.47	19.87
6.31	17.46	4.02	15.7	2.35	18.67
13.63	9.8	9.74	5.21	10.53	3.19
13.01	4.96	15.27	3.25	17.35	3.3
	17.85		11.93		13.06
	21.67		14.27		16.24
	13.22		11.71		11.88
11.995	**14.970**	**9.083**	**12.289**	**9.176**	**12.320**
15.078	**35.499**	**22.508**	**47.303**	**40.846**	**46.398**
0.3986 NS		**0.4341 NS**		**0.4716 NS**	
Na					
0.12	0.16	0.04	0.22	0.05	0.15
0.3	0.11	0.11	0.23	0.08	0.1
0.54	0.15	0.18	0.24	0.23	0.17
1	1.3	0.11	0.99	0.13	1.11
	1.17		1.44		1.15
	0.99		0.77		0.75
	0.1		0.09		0.16
0.490	**0.569**	**0.110**	**0.569**	**0.122**	**0.513**
0.145	**0.308**	**0.003**	**0.258**	**0.006**	**0.227**
0.8090 NS		**0.0426 S**		**0.0634 N**	

Pre- Rep		Reproductive		Post-Rep	
Herbs	Woody	Herbs	Woody	Herbs	Woody
K					
4.46	1	4.49	0.99	3.45	0.84
4.85	0.7	1.68	1.27	1.29	0.76
4.66	1.38	3.16	0.31	3.19	1.51
4.09	1.3	3.09	1.41	3.3	1.5
	0.3		2.98		1.66
	1.09		0.45		0.31
	1.8		0.4		0.4
4.515	**1.089**	**3.105**	**1.116**	**2.808**	**0.997**
0.106	**0.236**	**1.317**	**0.868**	**1.035**	**0.311**
0.000 S		**0.0118 S**		**0.0037 S**	
P					
0.24	0.22	0.3	0.17	0.36	0.14
0.31	0.13	0.18	0.16	0.23	0.17
0.3	0.32	0.26	0.33	0.28	0.14
0.27	0.14	0.23	0.3	0.26	0.3
	0.4		0.13		0.18
	0.21		0.1		0.27
	0.15		0.16		0.2
0.28	**0.224**	**0.243**	**0.193**	**0.283**	**0.2**
0.001	**0.010**	**0.003**	**0.008**	**0.003**	**0.004**
0.3221 NS		**0.3299 NS**		**0.0568 NS**	

N

1.9	1.25	1.88	1.3	1.33	1.11
1.36	1.16	1.05	1	1.04	1.66
2.01	2.11	1.88	1.82	1.89	0.94
0.93	1.73	2.05	1.37	1.55	1.87
	1.17		1.16		1.51
	1.21		1.02		1.52
	1.2		1.56		1.2
1.55	**1.404**	**1.715**	**1.319**	**1.452**	**1.404**
0.252	**0.137**	**0.203**	**0.088**	**0.129**	**0.108**
0.5921 NS		**0.1089 NS**		**08157 NS**	

Mg

21.85	16.28	15.95	21.28	18.12	18.53
21.63	7.45	16.14	7.9	11.89	6.3
29.7	6.4	14.92	2.1	32.76	5.13
16.1	12.51	30.23	25.08	13.77	14.5
	37.56		30.7		29.7
	30.71		23.43		33.35
	27.58		30.82		23.43
22.32	**19.784**	**19.31**	**20.187**	**19.135**	**18.706**
31.283	**148.765**	**53.286**	**122.891**	**89.315**	**118.928**
0.2285 NS		**0.8916 NS**		**0.9491 NS**	

B. Micronutrients

Micro elements though required in very minute quantities, but their importance could not be under rated in the growth and metabolism of human and animal health. Most of the trace elements have antagonizing effects for macro-minerals. The main sources of these minerals are water and soil upon which the forage plant species grow (McDowell, 2003). Mineral deficiencies after forage digestibility, herbage intake and ultimately decreases livestock production efficiency (Provenza, 1996; Khan *et al*., 2005). At the same time micro minerals can cause severe physiological disturbances if taken in excess. Heavy metals affect the nutritive values of agricultural products and also have deleterious effect on human beings. National and international regulations on food quality set the maximum permissible levels of toxic metals; hence heavy metals in food should be in safe limits (Radwan & Salama, 2006; Sobukola *et al*., 2010). Livestock rearing is a common practice in District Tank by the locals to earn their daily commodities and livelihood. Eight micronutrients were analyzed in selected plants (Table 28) with the following results:

1. Zinc (Zn)

Zinc is present in carbonic anhydrase (found in RBC) which play a key role in eliminating CO_2. Zn is also an activator of more than 30 enzymes. Its deficiency interferes with reproductive capacity of animals. Dwarfism and absence of sexual maturation are important symptoms in severe Zn deficiencies. Zn concentration was relatively higher in grasses than broad leaved species (Malik *et al*., 2010). Our findings agree with them because low Zn levels were found periodically in all woody species in the present study. There were significant differences between herbs and woody species and among different phenological stages (Table 29). This is also supported by Hussain & Durrani (2008) who reported significant differences in Zn contents of herbaceous and woody plant from Baluchistan. High concentration of Zn was observed in herbs than woody species (Table 28). Among the herbs, Zn contents varied from 37.76 ppm (*Tribulus terrestris*) to 72.23 ppm (*Trifolium alexandrianum*). Zinc contents were generally maximum in herbs at pre reproductive stages except *Tribulus terrestris*. Khan *et al*. (2006 a) also stated that concentration of Zn varied with plant phenology which is in line with our findings. In woody plants, Zn contents ranged from 17.93 (*Salsola*

foetida) to 43.83 (*Withania coagulans*). *Zizyphus mauritiana* and *Withania coagulans* had high Zinc contents at pre-reproductive stages. In rest of the woody species high Zn concentration was recorded at reproductive and post reproductive stages (Table 28). Zinc concentration in grasses of northern rangelands of Pakistan was not affected by maturity or change in climate (Sultan *et al*., 2008b). These findings are in contradiction to our study which showed prominent variation with the maturity of plants. This might be due to dry prevailing condition in the area. Similar reports were made by Carvlho & Saraiva (2005), who stated that water stress period was responsible for high concentration of Zn. District Tank is an arid rangeland where aridity, low rainfall, degraded soil conditions stress the plants especially during prolong summers.

2. Manganese (Mn)

Manganese is required to stimulate some enzymes such as arginase and thiaminase. Mn deficiency causes impaired growth, skeletal abnormalities and infant abnormalities. Manganese is considered to be the least toxic of the trace elements to birds and mammals. Manganese between 50 and 125 ppm affected haemoglobin formation in lambs and mature rabbits (Haetman *et al*., 1955). Woody plants contained significantly high Mn contents than herbs at post-reproductive stage (Table 29). These findings did not agree with Hussain & Durrani (2008) who reported high concentration of Mn in herbaceous than woody plants. In the present case, among the woody plants, it ranged from 13.85 ppm (*Prosopis cineraria*) to 56.2 ppm (*Withania coagulans*) which were well above 18 to 36 ppm, a range recommended by Anon. (1982, 1985) (Table 28). In herbs, it varied from 7.11 ppm (*Trifolium alexandrianum*) to 19.5 ppm (*Convolvulus arvensis*). A similar level of Mn in various forage plants has already been reported in Florida (Espinoza *et al*., 1991), and in plains of Pakistan (Khan *et al*., 2006b, 2007b). Generally, Mn contents reduced at reproductive stage in all the plants except *Convolvulus arvensis*, *Avena sativa*, *Suaeda fruticosa* and *Withania coagulans* where post reproductive stages exhibited lowest value. The findings agree with those of Khan *et al*. (2007 a) and Abbasi *et al*. (2009), who reported similar range for Mn in other forage plants.

3. Lead (Pb)

Lead is one of the most common causes of accidental poisoning in human and domestic animals. Lead concentration of 80 ppm in forages could be toxic to horses but

cattle could tolerate 200 ppm or more. Woody plants generally had higher Pb contents than herbs (Table 28). High concentration of lead was recorded in some vegetable and forages (Sobukola *et al*., 2010; Ahmad *et al*., 2009e). Among woody species, it ranged from 1.73 ppm (*Acacia nilotica*) to 7.66 ppm (*Zizyphus mauritiana*), while it varied from 0.8 ppm (*Trifolium alexandrianum*) to 1.56 ppm (*Tribulus terrestris*) among herbs. The Pb contents were high at post reproductive stages in *Avena sativa*, *Tribulus terrestris* and *Trifolium alexandrianum* and at pre-reproductive stages in *Convolvulus arvensis* among herbaceous palnts. Similarly, woody species exhibited high Pb contents at reproductive and post reproductive stages, respectively. But all these concentrations are below the upper limit for ruminants use. *Acacia nilotica ssp. nilotica* and *Suaeda fruticosa* had high contents at pre reproductive stages (Table 28). Lead contents were significantly higher at pre reproductive and insignificant at reproductive and post reproductive stages between herbs and woody plants (Table 29). Malik *et al*. (2010) also observed variations in the lead contents in some plants analyzed by them species which are in accordance to our findings.

4. Chromium (Cr)

Chromium (Cr) plays important role in the synthesis of fatty acids and cholesterols, metabolism of carbohydrates, proteins, lipids and has also been proved that it facilitates the action of insulin. Oral administration of 50 ppm of Cr has been associated with growth depression and liver and kidney damages in experimental animals. In the present study Cr concentration was high in woody plants than herbs, except *Calotropis procera* which exhibited the lowest (1.83 ppm) values, which is overall extremely low from toxic level (Tables 28 & 29). The Cr contents were maximum in *Avena sativa* and *Tribulus terrestris* at reproductive and post reproductive stages. Chromium level was highest at pre reproductive and post reproductive in *Convolvulus arvensis* and *Trifolium alexandrianum* among the herbs. It ranged from 1.83 ppm (*Calotropis procera*) to 22.3 ppm (*Withania coagulans*) among woody species. Mineral ion concentration decreases with increase in age both in the case of herbaceous plants (Rahim *et al*., 2008). Similarly, the highest Cr concentration was generally recorded at pre reproductive stages almost in all woody species which support the present investigation. The concentrations of Cr observed in the pasture forage plants from Salt Range (Pakistan) are significantly higher

than the critical levels. Thus, these forages may cause toxicities problems in animals grazing in that area (Ahmad *et al*., 2009e). These findings are opposing our results, where the Cr concentration almost in all plants and phenological stages were in acceptable range but showing variation in concentration with different phenological stages and habit of the forages. Statistical analysis showed insignificant differences between herbs and woody species and among various phenological stages (Table 28). Sharma *et al*. (2006) studied the heavy metal contents including Cr in different vegetables and forages and reported the concentration of Cr to be within the safe limits. Our results are in line with their conclusion.

5. Cadmium (Cd)

Cadmium is one of the most well known heavy metals. When it is exposed to environment through various sources, it gets accumulated in plants and higher organisms. In animals, it is known for disease related to liver and kidney. It is the most important carcinogenic element (Dwivedi *et al*., 2009). The woody plants generally showed higher Cd values than herbs (Table 28). It varied from 1.16 (herbs) to 3.57 (woody plants). Most of the investigated plants exhibited highest Cd concentration at pre reproductive or reproductive stages. There were no significant differences among different phenological stages and between herbs and woody plants (Table 29). Fytianos *et al*. (2001) reported no significant differences in the concentration of metals in most of the vegetables analyzed. The present findings are in line with them. The Cd levels in the present situation were below the critical values. Similar to our study low Cd concentration was observed in some fruits and vegetables in Nigeria (Sobukola *et al*., 2010). However, our findings are in contradiction with those of Farooq *et al*. (2008) and Radwan & Salama (2006), who reported the highest levels of Cd in strawberries, cucumber, dates spinach and other vegetables. The abilities of plants always vary to accumulate or avoid various heavy metals. Same is the situation in the present study whereby some plants have gathered and other has avoided cadmium accumulation.

6. Iron (Fe)

Iron is a constituent of blood pigment, hemoglobin, muscle protein, myoglobbulin and various enzymes. The deficiency of iron causes anemia and a decreases resistance to diseases. Very high levels of iron may cause nutritional problems

by decreasing phosphate absorption. Among herbs, the highest Fe contents were observed for *Avena sativa* (55.24 ppm) followed by *Convolvulus arvensis* (26.6 ppm) and *Tribulus terrestris* (25.01 ppm). *Trifolium alexandrianum* had lowest (17.04 ppm) Fe values. Among woody plants, *Prosopis cineraria* exhibited highest value (43.6 ppm) at pre-reproductive stage followed by *Suaeda fruticosa* (42.9 ppm) at reproductive stage; while the lowest contents (6.68 ppm) were observed in *Calotropis procera* at post reproductive stages (Table 28). This agrees with the findings of Hussain & Durrani (2008), who reported similar trend for Fe concentration from plants of Harboi rangeland. Gonzalez *et al.* (2006) also stated that Fe contents decreased with maturity of plants. The differences were insignificant between herbs and woody plants and among various growth stages (Table 29). Espinoza *et al.* (1991) also reported variations in Fe concentrations in their study in Florida, which also strengthen our findings. The dietary requirement of certain animals lies within 30 to 50 ppm (Anon., 1982, 1985). Iron contents in the present study are just in the range of the acceptable concentration. However, Reuter *et al.* (1986) reported as high as 524 ppm Fe in their study. Our findings are also in agreement with those of Akhtar *et al.* (2007) who reported similar findings in forages.

7. Nickle (Ni)

Nickle is present in RNA in rather high concentrations. It is also essential for urease activity in rumen microbes. Levels of Ni greater than 1000 ppm in the diet are toxic to most animals. The minimum and maximum levels of Ni contents were recorded from herbaceous plants. The concentration varied from 1.89 ppm (*Convolvulus arvensis*) to 5.65 ppm (*Trifolium alexandrianum*) (Table 28). Among the woody species, *Calotropis procera* showed the highest Ni levels at pre-reproductive stage. Tokalioglu & Kartal (2005) also showed high Ni contents in some plants, which are in line with our results. *Acacia nilotica ssp. nilotica* and *Withania coagulans* had highest Ni at reproductive stage. While the others had it at post reproductive stages. Sobukola *et al.* (2010) reported similar results. The differences were insignificant among different growth stages and among species (Table 29). The findings of Ahmad *et al.* (2009e) are in line with the present results as they also stated that insignificant variation in Ni concentration existed during various growth stages.

8. Copper (Cu)

Copper is necessary along with iron because it is required in red cell maturation. It is also important for normal bone formation. Symptoms of copper deficiency vary among species. Anemia is the general symptom along with depressed growth and bone abnormalities both in human and animal. Copper toxicity is very rare in animals when adequate supply of iron and Zn is present in diet. In the present study, high ranges of fluctuation in Cu concentration were observed between herbs and woody plants; and among different phenological stages (Table 28). Copper was highest (10.7 ppm) in *Convolvulus arvensis*, which decreased to 4.43 ppm in *Avena sativa* among the herbs. In woody plants, the average Cu contents varied from 6.1 ppm (*Withania coagulans*) to 13.13ppm (*Prosopis cineraria*). Generally, the Cu contents decreased toward maturity of the plants. Gonzalez *et al*. (2006) also reported decrease in mineral ion including Cu concentration with maturity in legumes and grasses. *Prosopis cineraria* surprisingly exhibited high Cu concentration at reproductive stage which is the toxic level. Livestock generally need 4.5 to 5 ppm Copper where as 8 to 25 ppm copper is toxic level (Anon., 1981, 1985; Hussain & Durrani, 2008). The differences between herbs and woody species and among different phenological stages were insignificant (Table 29). In the present case all plants seems to possess a slight high amount of Cu, while Akhtar *et al*. (2007) and Khan *et al*. (2006 a) reported deficiency of Cu in forage plants analyzed by them.

The over results is concluded that micro-minerals concentrations available in these forage plants to the grazing livestock were moderate. Therefore, there is no need of supplementing Cu in their feed for maintaining good health and yield of the local breed in rangelands of District Tank. However, the range land is under stress due to aridity and overgrazing providing insufficient forage to the grazing animals. It would be advisable to investigate proximate composition and digestibility of these forage plants for better understanding of poor health of livestock in this rangeland. Furthermore sustainable utilization of the present forages could be encouraged.

Table 28. Variation in micronutrients (ppm) at three phenological stages of some forage plants of District Tank.

Species	Phenological Stage	Zn ppm	Mn ppm	Pb Ppm	Cr ppm	Cd ppm	Fe ppm	Ni Ppm	Cu ppm
A. Herbs									
Convolvulus arvensis L.	Pre- Rep	52.2	19.5	1.8	5	2.7	24.51	1.67	13
	Reproductive	46.2	21.5	1.8	4	2.5	21.2	1.95	11.3
	Post- Rep.	36.3	17.5	1	7.1	1	34.71	2.05	7.8
	Mean	**44.9**	**19.5**	**1.53**	**5.36**	**2.06**	**26.8**	**1.89**	**10.7**
Avena sativa L.	Pre- Rep.	68.7	18.27	1.2	6	0.8	60.52	5.9	4.9
	Reproductive	44.2	10.96	1.5	7.2	1	57.61	3.49	5.1
	Post- Rep.	51.2	6.47	1.8	9.4	3.3	77.6	4.2	3.3
	Mean	**54.7**	**11.9**	**1.5**	**7.53**	**1.7**	**55.24**	**4.53**	**4.43**
Tribulus terrestris L.	Pre- Rep.	30	9.28	0.9	8	1.4	17.08	1.71	8.1
	Reproductive	38	9.14	1	9.01	1.2	26.85	3.4	8
	Post- Rep.	45.3	7.08	2.8	10.31	0.9	31.1	4.6	9
	Mean	**37.76**	**8.5**	**1.56**	**9.1**	**1.16**	**25.01**	**3.23**	**8.36**
Trifolium alexandrianum L.	Pre- Rep.	75.9	8.15	0.7	7	0.8	20.82	3.81	12.2
	Reproductive	78.4	5.11	0.8	5	1.3	19.24	7.48	10.41
	Post- Rep.	62.4	8.07	0.9	10	2.7	11.08	5.7	8.32
	Mean	**72.23**	**7.11**	**0.8**	**7.33**	**1.6**	**17.04**	**5.65**	**10.31**
B. Woody plants									
Zizyphus mauritiana Lam.	Pre- Rep.	39.9	21.39	7	12	0.8	21.32	4.62	10.3
	Reproductive	38.5	24.46	8	8	2.9	36.96	4.48	11.5
	Post- Rep.	34.6	26.87	8	14	1.3	30.17	5.6	5.4
	Mean	**37.66**	**24.24**	**7.66**	**11.33**	**1.66**	**29.48**	**4.9**	**9.06**

Acacia nilotica ssp. *nilotica* (L.) Wild. ex Delile	Pre- Rep.	16.4	30.7	2.3	16.1	2.9	35.35	3.1	12.7
	Reproductive	20.4	28.7	1.4	13.5	1.6	30.55	4.9	9.7
	Post- Rep.	30.1	32.5	1.5	11.21	2.1	39.42	1.9	11.7
	Mean	**22.3**	**30.63**	**1.73**	**13.6**	**2.2**	**35.1**	**3.3**	**11.36**
Prosopis cineraria (L.) Druce	Pre- Rep.	31.8	14.6	1.6	11	2.9	43.6	3.24	13
	Reproductive	36.3	10.36	2.7	10	2.7	41.93	2.59	11.3
	Post- Rep.	38	16.6	3.01	6	2	33	4.89	15.1
	Mean	**35.36**	**13.85**	**2.43**	**9**	**2.53**	**39.51**	**3.57**	**13.13**
Suaeda fruticosa Forssk. ex J. F. Gmelin	Pre- Rep.	15.5	38	3	16.6	3.4	33.16	1.71	7.3
	Reproductive	22	36	1.2	12	3	39.56	2.77	6.8
	Post- Rep.	28.4	34	2.2	8	1.9	42.9	3.93	5.7
	Mean	**21.96**	**36**	**2.13**	**12.2**	**2.76**	**38.54**	**2.8**	**6.6**
Salsola foetida Del.ex Spreng.	Pre- Rep.	16.2	19.44	1.8	8	2.8	17.73	2.44	9.3
	Reproductive	17	17.44	3.4	13	2	21.8	4.9	6.1
	Post- Rep.	20.6	19.72	2	15	1	25.32	3.97	8.6
	Mean	**17.93**	**18.86**	**2.4**	**12**	**1.93**	**21.61**	**3.77**	**8**
Calotropis procera ssp. hamiltonii (Wight) Ali	Pre- Rep.	34.5	31.04	3.5	0.5	3.3	10.21	5.5	7.2
	Reproductive	43.8	21.52	2	2	4.5	16.87	4.3	6.3
	Post- Rep.	44.4	33.92	4.31	3	2.8	6.68	4.39	8.9
	Mean	**40.09**	**28.82**	**3.27**	**1.83**	**3.53**	**11.25**	**4.73**	**7.46**
Withania coagulans (Stocks) Dunal	Pre- Rep.	46.3	55.5	4	21	1.6	37.82	2.8	7.1
	Reproductive	45.9	62.9	6.5	25	1.2	30.5	4.76	6.1
	Post- Rep.	39.3	50.2	5.5	21	2.1	40.62	2.7	5.1
	Mean	**43.83**	**56.2**	**5.33**	**22.33**	**1.63**	**36.31**	**3.42**	**6.1**

Table 29. Statistical analysis (T- test) of micronutrients of forage plants in District tank.

Pre- Rep		Reproduct		Post-Rep	
Herbs	Woody	Herbs	Woody	Herbs	Woody
Cu					
13	10.3	11.3	11.5	7.8	5.4
4.9	12.7	5.1	9.7	3.3	11.7
8.1	13	8	11.3	9	15.1
12.2	7.3	10.41	6.8	8.32	5.7
	9.3		6.1		8.6
	7.2		6.3		8.9
	7.1		6.1		5.1
9.550	**9.557**	**8.702**	**8.257**	**7.105**	**8.643**
14.217	**6.506**	**7.711**	**6.186**	**6.676**	**13.806**
0.9971 NS		**0.7898 NS**		**0.4864 NS**	

Pre- Rep		Reproduct		Post-Rep	
Herbs	Woody	Herbs	woody	Herbs	Woody
Zn					
52.2	39.9	46.2	38.5	36.3	34.6
68.7	16.4	44.2	20.4	51.2	30.1
30	31.8	38	36.3	45.3	38
75.9	15.5	78.4	22	62.4	28.4
	16.2		17		20.6
	34.5		43.8		44.4
	46.3		45.9		39.3
56.700	**28.657**	**51.700**	**31.986**	**48.8**	**33.629**
415.260	**160.036**	**329.027**	**142.125**	**119.740**	**62.962**
0.0188 S		**0.0554 S**		**0.0254 S**	

Mn					
19.5	21.39	21.5	24.46	17.5	26.87
18.27	30.7	10.96	28.7	6.47	32.5
9.28	14.6	9.14	10.36	7.08	16.6
8.15	38	5.11	36	8.07	34
	19.44		17.44		19.72
	31.04		21.52		33.92
	55.5		62.9		50.2
13.8	**30.096**	**11.678**	**28.769**	**9.780**	**30.544**
34.941	**189.76**	**48.856**	**292.595**	**26.923**	**123.103**
0.0543 NS		**0.0935 NS**		**0.0070 S**	

Pb					
1.8	7	1.8	8	1	8
1.2	2.3	1.5	1.4	1.8	1.5
0.9	1.6	1	2.7	2.8	3.01
0.7	3	0.8	1.2	0.9	3.4
	1.8		2.7		2
	3.5		2		4.31
	4		6.5		5.5
1.150	**3.314**	**1.275**	**3.500**	**1.625**	**3.690**
0.230	**3.408**	**0.209**	**7.080**	**0.776**	**4.987**
0.0167 S		**0.0593 NS**		**0.0806 NS**	

Cr

5	12	4	8	7.1	14
6	16.1	7.2	13.5	9.4	11.21
8	11	9.01	10	10.31	6
7	16.6	5	12	10	8
	8		13		15
	0.5		2		3
	21		25		21
6.500	12.171	6.303	11.929	9.202	11.173
1.667	44.669	5.045	48.702	2.107	37.139
0.0576 NS		0.1589 NS		0.4356 NS	

Fe

24.51	21.32	21.2	36.96	34.71	30.17
60.52	35.35	57.61	30.55	77.6	39.42
17.08	43.6	26.82	41.9	31.1	33
20.82	33.16	19.42	39.56	11.08	42.9
	17.73		21.8		25.32
	10.21		16.87		6.68
	37.82		30.5		40.62
30.733	28.456	31.263	31.163	38.622	31.1 59
403.55	147.59	318.475	85.361	783.243	155.548
0.8172 NS		0.9903 NS		0.5484 NS	

Co

2.7	0.8	2.5	2.9	1	1.3
2.06	2.9	0.8	1.6	3.3	2.1
1.4	2.9	1.2	2.7	0.9	2
0.8	3.4	1.3	3	2.7	1.9
	2.8		2		1
	3.3		4.5		2.8
	1.6		1.2		2.1
1.740	2.529	1.450	2.557	1.975	1.886
0.674	0.926	0.537	1.196	1.462	0.345
0.2033 NS		0.1075 NS		0.8702 NS	

Ni

1.67	4.62	1.95	4.48	2.05	5.6
5.9	3.1	3.49	4.9	4.2	1.9
1.71	3.24	3.4	2.59	4.6	4.89
3.81	1.71	7.48	2.77	5.7	3.93
	2.44		4.9		3.97
	5.5		4.3		4.39
	2.8		4.76		2.7
3.273	3.334	4.040	4.100	4.137	3.911
4.067	1.688	5.636	0.992	2.339	1.593
0.9436 NS		0.9845 NS		0.7964 NS	

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6	16.1	7.2	13.5	9.4	11.21
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60.52	35.35	57.61	30.55	77.6	39.42
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	10.21		16.87		6.68
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30.733	28.456	31.263	31.163	38.622	31.1 59
403.55	147.59	318.475	85.361	783.243	155.548
0.8172 NS		0.9903 NS		0.5484 NS	

Cd

2.7	0.8	2.5	2.9	1	1.3
2.06	2.9	0.8	1.6	3.3	2.1
1.4	2.9	1.2	2.7	0.9	2
0.8	3.4	1.3	3	2.7	1.9
	2.8		2		1
	3.3		4.5		2.8
	1.6		1.2		2.1
1.740	2.529	1.450	2.557	1.975	1.886
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Ni

1.67	4.62	1.95	4.48	2.05	5.6
5.9	3.1	3.49	4.9	4.2	1.9
1.71	3.24	3.4	2.59	4.6	4.89
3.81	1.71	7.48	2.77	5.7	3.93
	2.44		4.9		3.97
	5.5		4.3		4.39
	2.8		4.76		2.7
3.273	3.334	4.040	4.100	4.137	3.911
4.067	1.688	5.636	0.992	2.339	1.593
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Nutritional Evaluation

I. Proximate composition

The amount and nutritive quality of vegetation available to grazing animal determine the range animal productivity. Age and physiological function including growth maintenance, gestation, fattening and location determine the nutritional demands of livestock. Plant material is divisible into fibrous and non-fibrous fractions. In ruminants' fiber fraction providing energy are important as cellulose and hemicelluloses are easily digestible while the phenolic polymers like lignin are indigestible to hinder carbohydrate digestion. Most rangelands of Pakistan may have sufficient forage but of low palatability due to overstocking (Hussain & Durrani, 2009a). The proximate composition of some range forage has been carried out to see its possible role in the productivity of range lands in the investigated area.

1. Dry matter (DM)

The dry matter of plant or animal material is solid part, excluding all its constituents' water. The dry matter includes carbohydrates, fats, proteins, vitamins, minerals, and antioxidants (thiocyanate, anthocyanin, and quercetin). Carbohydrates, fats, and proteins providing the energy in foods, make up 90% of the dry weight of a diet. Water contents in foods vary widely. In the present study it was found that generally, herbaceous plants had more dry matter than woody species (Table 30). Similar results i.e. high DM for herbs was obtained from plants of rangelands of Harboi, Baluchistan (Hussain & Durrani, 2009b). The DM increased from 55.5% (*Avena sativa*), through 84.6% (*Tribulus terrestris*) to 86.43% (*Trifolium alexandrianum*). Among woody species, the dry matter averaged from 42.27% in *Withania coagulans* to 71.46% in *Zizyphus mauritiana*. DM was low at pre-reproductive stage, which gradually increased with maturity in *Zizyphus mauritiana*. There were no significant differences in dry matter of herbaceous and woody species at reproductive and post reproductive stages (Table 31). The general observed trend was that dry matter of herbaceous and woody plants increased with advancing in ages. Similar result was reported by other work (Storecheier *et al*., 2002; Kramberger & Klemmencic, 2003), which support the present findings.

2. Organic matter (OM)

The woody plants had greater OM than herbaceous species (Table 30). It varied from 90.04% in *Prosopis cineraria* to 93.48% in *Zizyphus mauritiana*. The lowest OM contents were recorded in *Withania coagulans* (55.31%) and *Suaeda fruticosa* (56.31%) at post reproductive stages. At reproductive stage, OM was highest in *Zizyphus mauritiana* (95.1%) and lowest in *Withania coagulans* (60.2%). Sultan *et al.* (2007) reported that usually OM concentration was high in herbaceous than trees which is in contradiction with the present work. The OM of herbaceous plants was as high as 88.4% in *Tribulus terrestris*, which reduced to 76.1% in *Convolvulus arvensis*. *Trifolium alexandrianum* had the highest (96.2%) OM at reproductive stage that gradually decreased at pre-reproductive and post reproductive stages. *Avena sativa* had the lowest and highest OM at pre- and post reproductive stages respectively (Table 30). The differences between herbaceous and woody plants and among different phenological stages were insignificant (Table 31). Generally, the OM contents were low at pre-reproductive stages that gradually enhanced with advancing maturity of plants. This is in line with the findings of Hussain & Durrani (2009b) who reported similar trend for forage plants of Harboi range lands where OM decreased with maturity. However, on the contrary *Suaeda fruticosa* and *Salsola foetida* had decreased OM at post reproductive stages. This is what has been reported by Chiesa *et al.* (2008) who stated that OM and other chemicals decreased linearly with age of growth. On the contrary Peiretti *et al.* (2004) reported the reverse trend with advancing stages. Sultan *et al.* (2008) observed that the DM increased with age in the latter stages of certain grasses and this is also opposite to our findings.

3. Crude protein (CP)

Proteins are fundamental components of all living cells and include many substances, such as enzymes, hormones, and antibodies that are necessary for the proper functioning of an organism. They are essential in the diet of animals for the growth and repair of tissue. Crude protein referring to all the nitrogenous compounds present in forage feed is reliable source of overall nutritional status. They are directly related to digestibility, vitamins, calcium and phosphorus contents. These all features decline with low crude protein to almost deficient level (Gannskop & Bohner, 2001; Hussain &

Durrani, 2009a). The CP contents ranged from 5.3% in *Convolvulus arvensis* at pre reproductive stage to 13.6% in *Avena sativa* among herbs (Table 30). *Tribulus terrestris* (11.3%) and *Trifolium alexandrianum* (6.0%) had lowest CP contents at reproductive stages. Woody species usually contained low CP contents than herbs, except *Zizyphus mauritiana* and *Acacia nilotica*, which possessed insignificantly high CP contents at pre-reproductive stages. Bukhsh *et al*. (2007) reported that crude proteins, varied with plant parts and phenological stages, thus supporting the present results. It ranged from 6.14% (*Calotropis procera*) to 11.8% (*Zizyphus mauritiana*) among woody plants. *Zizyphus mauritiana* had maximum CP value at pre-reproductive (16.6%) and reproductive (11.3%) stages while, *Prosopis cineraria* showed the lowest crude protein at these stages. At pre-reproductive and post reproductive stages *Salsola foetida* and *Suaeda fruticosa*, respectively had highest and lowest CP contents. Generally, the CP contents ranked high at pre reproductive stages than at other growth stages with exception of *Convolvulus arvensis*, exhibiting lowest value at pre reproductive stage. This agrees with Khan *et al*. (2002) and Dairo & Adanlawo (2007) and Hussain & Durrani (2009b) who also reported high crude protein contents during early growth stages than others. The deficiency of protein leads to reduced appetite, low feed intake and poor food efficiency that in turns lead to poor growth and development of livestock (Anon., 1981, 1985). The present study showed that woody species generally contained low CP contents compared to herbs. Our results agree with those of Starks *et al*. (2006) who reported high concentration in herbaceous forages. Similar findings were reported by Karki *et al*. (2000) from the grasslands. Sultan *et al*. (2009) reported high level of CP in *Chenopodium album, Polygonum amplexicaule* and *Urtica dioca*. There is always variability in the amount and increase/decrease of CP in different species and between growth stages.

4. Crude fiber (CF)

The crude fiber is the organic residue remaining after digesting with 0.255 N H_2SO_4 and 0.313 N NaOH. The compounds removed are predominantly protein, sugar, starch, lipids and portions of both the structural carbohydrates and lignin. In the present study crude fiber generally ranked high in herbs than woody species (Table 30). Enujiugha (2003) also reported that *Tetracarpidium conophorum* exhibited low crude fiber contents compared to the herbs and this supports our findings. In our case it ranged

from 23.4% in *Trifolium alexandrianum* to 32.3% in *Convolvulus arvensis* among herbs. Reproductive stages generally had high value that gradually declined towards maturity of the plants. *Avena sativa* had highest CF at pre reproductive stage, while in *Tribulus terrestris* the post reproductive stage had the maximum. Hussain & Durrani *et al.* (2009b) and Gutierrez *et al.* (2008) reported decline in crude fibers toward the maturity of forages. This was also true in our case. Among woody species, the highest CF (29.43%) was observed in *Salsola foetida*, which decreased to 18.23% in *Calotropis procera*. Crude fiber contents differed insignificantly between herbs and woody and among various growth stages (Table 31). Mature plants usually had high CF than young plants. Our findings are also in line with those of Sultan *et al.* (2009) who reported low CP contents in herbaceous flora. The level of crude fibers in the present study was greater when compared to other forages species (Bukhsh *et al.*, 2007; Sultan *et al.*, 2007).

5. Ether extracts (EE)

The part of a complex organic material that is soluble in ether and consists chiefly of fats and fatty acids. It is a measure of the fat or oil (lipid) contents of the feed. Fats and oils are extremely rich sources of energy. Because of impedance of microbial fermentation, ruminant diets should be limited to about 4% fat. Woody species had higher ether extract than herbs (Table 30). The differences were significant between post reproductive stages between herbs and woody plants (Table 31). Ether extract was high in *Acacia nilotica ssp. nilotica* (8.4%) and lowest in *Salsola foetida* (2.56%). *Zizyphus mauritiana*, *Calotropis procera* and *Withania coagulans* showed high ether extract at reproductive, pre-reproductive and post reproductive stages, respectively. Maximum ether extract value (13.2%) was achieved for *Avena sativa* especially at pre reproductive stage that narrowed down to 2.3% in *Salsola foetida*. Our findings are in line with Hussain & Durrani (2009b), Coskun *et al.* (2004), Cherney & Chenrey (2005).

6. Ash contents

When either organic compounds are decomposed or released at high temperature (500 - 600 ^{0}C), the remaining residue is the ash. This residue consists of oxides and salts containing anions such as phosphates, chlorides, sulfates, and other halides and cations such as sodium, potassium, calcium, magnesium, iron, and manganese which are important constituents of animal diet. Ash contents were generally high in herbaceous

species than woody species (Table 30). The variation was from 8.5% in *Trifolium alexandrianum* to 16.84% in *Convolvulus arvensis* at pre reproductive stages. These results are in contradiction with those of Husain & Durrani (2008, 2009b) but in line with Sultan *et al*. (2007 & 2008a). The lowest ash contents were recorded in *Avena sativa* and *Trifolium alexandrianum* at post reproductive stages. At reproductive stage, the ash contents were highest in *Convolvulus arvensis* (10.3%) and lowest in *Avena sativa* (6.7%). Hameed *et al*. (2008) also reported highest contents of ash in Polygonaceous herbaceous plant and is what we have also concluded. The ash contents of woody tested species ranged from maximum (10.53%) by *Prosopis cineraria* to 5.2% in *Withania coagulans*. *Acacia nilotica ssp. nilotica* having the maximum ash contents at pre-reproductive stage got lowered at reproductive and post reproductive stages. The differences between ash contents of herbs and woody species were insignificant at all the growth stages (Table 31). This is in contrast with the findings of Sultan *et al*. (2010) who reported significant difference of ash contents in forage plants. Generally, as a whole the ash contents were high at pre-reproductive stages that declined gradually towards reproductive stage. However, in some cases, e.g. *Avena sativa* and *Acacia nilotica ssp. nilotica* the ash contents were lowest at post reproductive stage. This is quite possible as plants vary in their ability to chemical changes in life cycle. Ash content plays important role in promoting balanced growth of animals. Similar to our findings, Hussain *et al*. (2010a) also reported that ash contents progressively decline with maturity of some forages. In the present study we also recorded high ash contents in some cases like *Avena sativa* and *Trifolium alexandrianum* at advance growth stages. This increase or decrease of ash contents may be due to variation in soil and other habitat features that needs evaluation.

7. Nitrogen free extracts (NFE)

Generally herbs (Table 30) had slightly higher NFE value than woody species, but the differences were significant only between herbs and woody plants during reproductive stages (Table 31). The lowest (43.9%) and the highest (56.0%) NFE values among the herbs were exhibited respectively by *Convolvulus arvensis* and *Tribulus terrestris*. Among woody plants, NFE was highest (50.26%) in *Acacia nilotica ssp. nilotica* and lowest in *Salsola foetida* (33.9%). Similarly, Nantoume *et al*. (2002) and

Azim *et al*. (2011) reported highest NFE values in *Acacia nilotica ssp. nilotica* and lowest in *Melia azedarch* which is in line with our finding. Daccord *et al*. (2002) stated that NFE values were generally high at pre-reproductive stages that declined with advancing age. However, in *Salsola foetida*, *Calotropis procera* and *Withania coagulans* the NFE was high at post reproductive stage. (Hussain & Durrani, 2009b) also observed similar trend while working on the shrub forages in Harboi range lands.

8. Carbohydrates

It is a group of organic compounds that includes sugars, starches, celluloses, and gums. It serves as a major energy source in the diet of animals. These compounds are produced by photosynthetic plants and contain only carbon, hydrogen, and oxygen, usually in the ratio 1:2:1. Carbohydrates perform numerous important roles in animals. Polysaccharides serve for the storage of energy (e.g. starch and glycogen) and as structural components (e.g. cellulose in plants and chitin in animal). In the present case, the lowest (18.6%) and highest (60.36%) carbohydrates contents were observed respectively in *Convolvulus arvensis* and *Tribulus terrestris* (Table 30). The findings of Fulkerson *et al*. (2001) are in line with the present results who stated that grasses and forbs were rich in carbohydrates than trees and shrubs. Excepting *Convolvulus arvensis* and *Avena sativa*, carbohydrate contents were usually high in herbs than woody plants. Chatterton *et al*. (2006) also reported similar trend in oats. Among woody plants, it was maximum (53.56%) in *Prosopis cineraria* and minimum (19.73%) in *Calotropis procera*. The differences were significant between herbs and woody plants and among all the growth stages (Table 31). Hopkins *et al*. (2002) reported that herbs yielded more carbohydrates than woody forage which are parallel with our findings.

II. Various Energy levels

1. Gross energy (GE)

Gross energy represents the total combustible energy in a feed stuff. The amount of energy needed is measured as digestible energy (DE), metabolized energy (ME) and total digestible nutrients (TDN). These values always differ among the species and phenological stages of plants. The present results recorded slightly higher GE in woody plants than herbs (Table 32). Similar trend was reported by Hussain & Durrani (2009b). Generally, GE increased from 349.1% in *Salsola foetida* to 606.67% in *Calotropis*

procera among the woody species. The GE of *Withania coagulans* was exceptionally lowers (60.36%). Among herbs, GE fluctuated between 282.06% in *Avena sativa* to 507.34% in *Convolvulus arvensis*. *Tribulus terrestris* and *Trifolium alexandrianum* had the maximum GE at reproductive stage. It was minimum in *Avena sativa* at the same stage. Statically, it was insignificant between and among herbs and woody plants (Table 33).

2. Digestible energy (DE)

In herbs the DE was maximum in *Convolvulus arvensis* (5.53 Mcal/Kg) followed by *Tribulus terrestris* (3.67 Mcal/Kg) and *Avena sativa* (3.02 Mcal/Kg) (Table 32). The lowest DE (2.4 Mcal/Kg) was observed in *Trifolium alexandrianum*. Among the woody plants, DE increased from 2.17 Mcal/Kg (*Suaeda fruticosa*) to 4.48 Mcal/Kg (*Calotropis procera*). Distel *et al*. (2005) also reported sporadic high and low DE existing in majority of shrubby plants thus supporting our views. Generally, the pre-reproductive stage had highest DE except *Prosopis cineraria* and *Calotropis procera*. In these two plants DE was at the peak at post reproductive stage. Benavides (2000) reported opposite trend that DE generally increased with maturity of the plants. The differences between herbs and woody species were non-significant in all the growth stages (Table 33).

3. Metabolized energy (ME)

The metabolized energy averaged in between 3.29 Mcal/Kg (*Avena sativa*) to 4.33 mcal/Kg (*Trifolium alexandrianum*) among herbs, while among woody species it was 1.9 Mcal/Kg (*Withania coagulans*) to 4.17 Mcal/Kg (*Suaeda fruticosa*) (Table 32). Generally, the pre-reproductive stages had more ME in majority of the tested species. Sultan *et al*. (2007) observed decrease in ME with maturity of herbaceous species and in the present study we also got decline in ME with advancing stage of plants. The differences were significant at reproductive stage between herbs and woody plants (Table 33). Similar trend has been demonstrated in other woody plants (Abdulrazak *et al*., 2000, 2001; Ondiek *et al*., 2000; Bakshi & Wadhwa, 2004). Sheep and goat generally need 0.5 to 5.62 Mcal/kg/day ME for their routine maintenance (Hussain & Durrani, 2009b). The present results shows a little shortage for metabolized energy which could be supplemented by other feeds.

4. Total digestible nutrients (TDN)

The total digestible nutrients were generally higher in woody species than herbs (Table 32). The TDN ranged in between 46.2% in *Tribulus terrestris* to 65.12% in *Avena sativa* among herbs while it ranged from 44.33% (*Withania coagulans*) to 73.09% in *Zizyphus mauritiana* among woody plants. The differences between and among herbs and woody species were insignificant (Table 33). These findings are in line with Hussain & Durrani (2009b) and Rahim *et al*. (2010) who also concluded similar results.

III. Cell Wall Constituents

1. Neutral detergent fiber (NDF)

Neutral Detergent Fiber (NDF) is the most common measure of fiber used for animal feed analysis, but without representing a unique class of chemical compounds. NDF measures most of the structural components in plant cells (i.e. lignin, hemicellulose and cellulose), but not pectin. It seems that NDF concentration of woody plants was generally higher than herbs during all the growing seasons (Table 34). Sultan *et al*. (2007 & 2008a) determined similar results in their study. It was observed that the average NDF value was highest (46.07%) in *Trifolium alexandrianum* and lowest (39.94%) in *Convolvulus arvensis*. *Convolvulus arvensis*, *Avena sativa* and *Trifolium alexandrianum* gained the highest value at pre-reproductive stages. While *Tribulus terrestris* had the highest NDF contents at post reproductive stages. Our findings are in line with Hussain & Durrani (2009b) who reported highest NDF values during pre reproductive stage in forage grasses from Harboi rangeland, Kalat, Baluchistan. Among the woody plants, the highest NDF values (70.14%) were recorded for *Acacia nilotica ssp. nilotica* and the lowest (45.35%) for *Calotropis procera*. There was increasing trend of NDF from pre reproductive to post reproductive in *Suaeda fruticosa* and *Tribulus terrestris*. The results agree with Ganskopp & Bohnert (2003), Kramberger & Klemencic (2003) and Sultan *et al*. (2007) who recorded increase in NDF concentration with advancing stages. However, for *Trifolium alexandrianum* and *Zizyphus mauritiana*, this trend was reversed. The differences were highly significant between herbs and woody plants at all the stages (Table 35). Sultan *et al*. (2009) also reported similar findings regarding NDF in certain plants.

2. Acid detergent fiber (ADF)

The present analysis of forage indicated that woody plants generally had higher ADF contents than herbs at reproductive and post reproductive stages (Table 34). The lowest (24.73%) NDF values among herbs were found in *Trifolium alexandrianum* and highest (39.36%) in *Convolvulus arvensis*. Sultan *et al*. (2008c) similarly reported high NDF in forage leaves of 12 trees including *Celtis eriocarpa* and *Morus alba* which agree with our findings. The lowest (20.89%) and highest (39.86%) ADF values were respectively found in *Calotropis procera* and *Acacia nilotica ssp. nilotica* among woody species. This is in line with those of (Starks *et al.*, 2006 and Lukhele & Ryssen, 2003) who also reported increasing trend in NDF contents in certain woody species. Over all, the maximum NDF values were recorded either at pre reproductive or at post reproductive stages. *Withania coagulans* and *Suaeda fruticosa* had low ADF values at post reproductive stage. While Zhao *et al*. (2008) reported reverse trend in NDF concentration in forages. Differences in ADF contents were statistically insignificant between herbs and wood species (Table 35). The results agree with those studies of Ganskopp & Bohnert (2003), Kramberger & Klemencic (2003) and Sultan *et al*. (2007) who recorded irregular increase or decrease in ADF concentration with advancing stages. Similarly, Ashraf *et al*. (1995) and Hussain & Durrani (2009b) also observed increase or decrease in NDF in fodder species at different growth stages. All these findings support the present findings. This study reports variation in the concentration of ADF in different plants at various phenological stages.

3. Hemicellulose

Except *Withania coagulans* and *Calotropis procera*, woody species generally had greater hemicelluloses contents than herbs (Table 34). The differences between and among herbs and woody species were non-significant (Table 35). Among the herbs, hemicelluloses ranged from 10.84% (*Convolvulus arvensis*) to 4.86% (*Trifolium alexandrianum*). The hemicelluloses contents were higher in herbaceous species than shrubs as observed by Viengsavanh & Inger (2002) and Rubanza *et al*. (2003). This is in agreement with the present situation. It was high in *Convolvulus arvensis* and *Avena sativa* at pre-reproductive stage, *Trifolium alexandrianum* at reproductive and *Tribulus terrestris* at post reproductive stages, respectively. As a whole mong the woody species

hemicelluloses contents were maximum (18.76%) in *Zizyphus mauritiana* and the lowest (3.15%) in *Withania coagulans*. It was high in *Zizyphus mauritiana*, *Prosopis cineraria*, *Salsola foetida* and *Suaeda fruticosa* at post reproductive stages and in *Acacia nilotica ssp. nilotica* at reproductive stage. The differences were insignificant between and among herbs and woody plants (Table 35).

4. Acid detergent lignin (ADL)

The ADL values ranged in between 2.7% (*Trifolium alexandrianum*) to 7.77% (*Convolvulus arvensis*) among the herbaceous species (Table 34). *Convolvulus arvensis* had the highest ADL at reproductive and post reproductive stages while *Tribulus terrestris* and *Trifolium alexandrianum* showed the lowest ADL value at pre reproductive stage. Similarly, among woody plants a maximum of 6.26% ADL was recorded in *Zizyphus mauritiana* and the least (3.4%) in *Salsola foetida*. Bakshi & Wadhwa (2004) also reported irregular trends of increase or decrease in ADL concentration in the leaves of forages which are similar to our findings. There was a decreasing tendency of ADL from pre-reproductive to post-reproductive stages in woody species. Among the herbs, the trend was reversed. Similarly, Zhao *et al.* (2008) reported that grasees usually exhibited high ADL concentration in earlier stages than woody species. These findings agree with what we have reported. The statistical analysis showed insignificant differences between herbs and woody species in different phenelogical stages (Table 35). Hussain & Durrani (2009b) stated that rangeland productivity might be improved by proper ecological management including quantity and quality of forage, stocking rate, grazing period, fertilization of soil and replacing of the existing livestock with improved varieties. It is true that in the present case local breed was observed all the way. This can be possible with awareness and participation of the local of the area.

Table 30. Proximate composition (%) of some herbaceous and woody forage plants of District Tank.

Species	Phenological Stage (%)	Dry matter (%)	Organic matter (%)	Crude protein (%)	Crude fiber (%)	Ether extract (%)	Ash contents (%)	Nitrogen free extract (%)	Carbohydrate contents (%)
A. Herbs									
Convolvulus arvensis L.	Pre- Rep.	35.7	71.3	5.3	30.3	2.3	16.84	46.3	15.5
	Reproductive	68.5	80.3	12.3	35.4	4.5	10.3	45.3	20.3
	Post- Rep.	61.3	76.6	10.2	31.2	3.1	11.5	40.1	18.4
	Mean	**55.17**	**76.1**	**9.26**	**32.3**	**3.3**	**12.86**	**43.9**	**18.06**
Avena sativa L.	Pre- Rep.	53.41	80.31	13.6	24.1	13.2	8.5	60.5	31.3
	Reproductive	55.31	92.3	8.9	17.1	4.5	6.7	55.3	26.3
	Post- Rep.	57.32	91.3	8.9	15.2	2.3	5.7	41.2	24.4
	Mean	**55.5**	**87.97**	**10.46**	**18.8**	**6.66**	**6.96**	**52.33**	**27.33**
Tribulus terrestris L.	Pre- Rep.	80.1	81.5	13.26	22.1	3.2	10	58.3	45.3
	Reproductive	90.2	93.2	11.3	31.2	2.1	8.3	58.5	60.5
	Post- Rep.	83.5	90.5	11.5	32.3	2	9.5	51.21	75.3
	Mean	**84.6**	**88.4**	**12.02**	**28.53**	**2.43**	**9.26**	**56**	**60.36**
Trifolium alexandrianum L.	Pre- Rep.	90.3	89.1	7.3	23.3	3.2	8.5	54.5	40.1
	Reproductive	95.3	96.2	6	24.5	1.11	7.6	61.51	65.7
	Post- Rep.	73.7	70.2	6.9	22.4	1.9	6.6	50.3	45.2
	Mean	**86.43**	**85.16**	**6.73**	**23.4**	**2.07**	**7.56**	**55.43**	**50.33**
B. Woody species									
Zizyphus mauritiana Lam.	Pre- Rep.	56.6	92.1	16.6	23.4	10.21	10.2	49.51	32.51
	Reproductive	76.8	95.1	11.3	20.2	8.6	9.9	47.3	53.6
	Post- Rep.	80.7	93.26	7.5	19.61	5.3	10.21	44.3	55.71
	Mean	**71.46**	**93.48**	**11.8**	**21.07**	**8.03**	**10.1**	**47.03**	**47.27**

Acacia nilotica ssp. *nilotica* (L.) Wild. ex Delile	Pre- Rep.	60.3	91.31	14	21.1	9.3	11.3	51.2	30.2
	Reproductive	62.2	94.2	7.5	22.2	8.4	8.25	50.3	36.2
	Post- Rep.	64.2	89.3	10.1	22.6	7.5	5.4	49.3	37.1
	Mean	**62.23**	**91.6**	**10.53**	**21.96**	**8.4**	**8.33**	**50.26**	**34.5**
Prosopis cineraria (L.) Druce	Pre- Rep.	69.1	85.31	6.5	13.6	6.61	11.2	40.2	50.1
	Reproductive	50.2	90.32	5.61	25.2	6.32	10.21	50.35	55.3
	Post- Rep.	78.2	94.51	10.2	20.31	6.32	10.21	50.35	55.3
	Mean	**65.83**	**90.04**	**7.43**	**19.7**	**6.41**	**10.53**	**46.96**	**53.56**
Suaeda fruticosa Forssk. ex J. F. Gmelin	Pre- Rep.	74.61	66.3	10.2	20.23	4.52	6.52	60.2	30.2
	Reproductive	71.51	71.2	5.61	28.32	4.55	5.71	40.3	35.61
	Post- Rep.	33.5	56.31	4.31	35.24	4.5	8.11	45.3	40.5
	Mean	**59.87**	**64.6**	**6.7**	**27.93**	**4.52**	**6.76**	**48.6**	**35.43**
Salsola foetida Del.ex Spreng.	Pre- Rep.	47.3	70.2	13.22	26.9	2.3	6.32	35.3	25.2
	Reproductive	45.2	65.31	10.32	25.21	1.5	4.8	30.2	27.3
	Post- Rep.	50.23	65	8.41	36.2	3.9	7.8	36.2	22.4
	Mean	**47.57**	**66.83**	**10.65**	**29.43**	**2.56**	**6.3**	**33.9**	**24.96**
Calotropis procera ssp. hamiltonii (Wight) Ali	Pre- Rep.	40.3	75.3	7.61	27.1	6.51	11.3	44.31	19.4
	Reproductive	45.21	77.4	1.52	15.2	3.23	5.61	40.21	17.5
	Post- Rep.	66.3	82.3	9.31	12.4	4.51	7.8	51.35	22.3
	Mean	**50.6**	**78.33**	**6.14**	**18.23**	**4.75**	**8.23**	**45.3**	**19.73**
Withania coagulans (Stocks) Dunal	Pre- Rep.	31.32	61.31	8.61	25.61	3.2	5.6	33.61	20.82
	Reproductive	44.2	60.2	9.31	20.62	3.5	4.7	41.3	21.91
	Post- Rep.	51.3	55.31	11.31	13.6	4.36	5.32	49.51	25.31
	Mean	**42.27**	**58.94**	**9.74**	**19.94**	**3.68**	**5.2**	**41.46**	**20.68**

Table 31. Statistical analysis (T- test) of proximate composition of herbs and woody plants of District Tank.

Pre- Rep stage		Reproductive stage		Post-Rep stage	
Herbs	Woody	Herbs	Woody	Herbs	Woody
Dry matter					
35.7	56.6	68.5	76.8	61.3	80.7
53.41	60.3	55.31	62.2	67.32	64.2
80.1	69.1	90.2	50.02	83.5	78.2
90.3	74.61	95.3	71.5	73.4	33.5
	47.3		45.2		50.23
	40.3		45.2		66.3
	31.32		44.2		51.3
70.378	**54.304**	**77.328**	**56.446**	**71.880**	**60.633**
313.349	**244.004**	**350.469**	**186.37**	**106.848**	**281.633**
0.1511 NS		**0.0605 NS**		**0.2603 NS**	
Carbohydrate					
15.4	32.51	20.3	53.6	18.4	55.71
51.5	30.2	26.3	36.2	24.4	37.1
45.3	50.1	60.5	30.2	75.3	55.3
40.1	30.2	65.7	35.61	45.2	40.5
	25.2		27.3		22.4
	19.4		17.5		22.3
	20.32		21.91		25.31
38.075	**29.704**	**43.200**	**31.76**	**40.825**	**36.946**
250.229	**106.480**	**538.520**	**139.036**	**660.109**	**210.517**
0.3104 NS		**0.2973 NS**		**0.7519 NS**	

Pre- Rep		Reproductive stage		Post-Rep stage	
Herbs	Woody	Herbs	woody	Herbs	Woody
Organic matter					
71.3	92.1	80.3	95.1	76.6	93.26
80.31	91.31	92.3	94.2	91.3	89.3
81.5	85.31	92.2	90.32	90.5	94.51
89.1	66.3	96.2	71.2	70.2	56.31
	70.2		65.31		65
	75.3		77.4		82.3
	61.31		60.2		55.31
75.553	**77.404**	**90.250**	**79.104**	**82.15**	**76.570**
156.442	**151.749**	**47.470**	**203.762**	**109.02**	**298.601**
0.1818 NS		**0.1826 NS**		**0.5760 NS**	
Crude Protein					
5.3	16.6	12.3	11.3	10.2	7.5
13.6	14	8.9	7.5	8.9	10.1
13.26	6.5	11.3	5.61	11.5	10.2
7.3	10.2	6	5.6	6.9	4.31
	13.22		10.32		8.41
	7.61		7.52		9.31
	8.61		9.31		11.31
9.865	**10.963**	**9.625**	**8.166**	9.375	8.734
17.632	**13.895**	7.876	4.958	3.849	5.364
0.6633 NS		**0.3640 NS**		**0.6538 NS**	

Crude fiber

31.3	23.4	35.4	21.2	31.2	19.61
24.1	21.1	17.1	22.2	15.2	22.6
22.1	13.6	31.2	25.2	32.3	20.31
23.3	30.23	24.5	26.32	22.4	35.24
	26.9	28.32	25.21		36.2
	25.21		15.2		12.4
	36.2		20.62		13.6
25.200	**25.234**	**27.050**	**22.279**	**25.275**	**22.851**
17.213	**50.632**	**64.150**	**14.581**	**64.743**	**90.585**
0.9932 NS		**0.2054 NS**		**0.6794 NS**	

Ash

16.84	10.2	10.3	9.9	11.5	10.21
8.5	11.3	6.7	8.25	5.7	5.4
10	11.2	8.3	8.5	9.5	10.21
6.6	6.52	7.6	5.71	6.6	8.11
	6.32		4.8		7.8
	11.3		5.61		7.8
	5.32		4.7		5.32
10.485	**8.880**	**8.225**	**6.781**	**8.325**	**7.836**
19.885	**7.272**	**2.343**	**4.269**	**7.109**	**3.936**
0.4690 NS		**0.2573 NS**		**0.7349 NS**	

Ether extract

2.3	10.21	4.5	8.6	3.1	5.3
13.2	9.3	4.5	8.4	2.3	7.5
3.2	6.61	2.1	6.51	2	6.32
3.2	4.52	1.11	4.55	1.9	4.5
	2.3		1.5		3.9
	6.51		3.23		4.51
	3.2		3.5		4.36
5.475	**6.093**	**5.550**	**5.184**	**2.325**	**5.199**
26.702	**8.818**	**14.970**	**7.400**	**0.296**	**1.653**
0.8034 NS		**0.8572 NS**		**0.0024 S**	

NFE

46.3	49.51	45.3	47.3	40.1	44.3
60.5	51.2	55.3	50.3	41.2	49.3
58.3	40.2	58.5	45.41	51.21	50.35
54.5	60.2	61.51	40.3	50.3	45.3
	35.3		30.2		36.2
	44.31		40.21		51.35
	33.31		41.3		49.51
54.900	**44.861**	**55.152**	**42.146**	**45.702**	**46.187**
39.013	**90.658**	**49.572**	**42.381**	**34.377**	**26.522**
0.0945 NS		**0.0127 S**		**0.8893 NS**	

Table 32. Various forms of energies available to livestock in selected plants of District Tank.

Species	Phenological Stage	Gross energy	TDN %	DE Mcal/Kg	ME Mcal/Kg
A. Herbs					
Convolvulus arvensis L.	Pre- Rep.	521.32	53.41	5.6	4.3
	Reproductive	510.51	54.34	6.7	3.9
	Post- Rep.	490.21	63.54	4.3	2.63
	Mean	**507.34**	**57.09**	**5.53**	**3.61**
Avena sativa L.	Pre- Rep.	395.42	63.83	3.3	4.1
	Reproductive	38.41	72.25	2.98	3.8
	Post- Rep.	412.36	59.3	2.8	1.98
	Mean	**282.06**	**65.12**	**3.02**	**3.29**
Tribulus terrestris L.	Pre- Rep.	361.22	45.3	4.5	3.53
	Reproductive	390.32	43.3	3.4	4.54
	Post- Rep.	95.45	51.5	3.4	3.52
	Mean	**282.33**	**46.2**	**3.76**	**3.86**
Trifolium alexandrianum L.	Pre- Rep.	370.6	55.3	2.4	4.62
	Reproductive	380.5	55.3	2.3	4.72
	Post- Rep.	365.4	58.4	2.5	3.66
	Mean	**372.16**	**63**	**2.4**	**4.33**
B. Woody species					
Zizyphus mauritiana Lam.	Pre- Rep.	440.02	83.41	4.91	3.92
	Reproductive	445.31	74.52	4.5	2.85
	Post- Rep.	434.54	61.34	3.98	2.2
	Mean	**439.96**	**73.09**	**4.46**	**2.99**
Acacia nilotica ssp. nilotica (L.) Wild. ex Delile	Pre- Rep.	552.3	60.8	3.25	1.98
	Reproductive	506.42	63.51	3.25	1.85
	Post- Rep.	522.3	66.32	3.25	2.05
	Mean	**527**	**63.54**	**3.25**	**1.96**

Prosopis cineraria (L.) Druce.	Pre- Rep.	490.5	70.2	3.95	6.8
	Reproductive	495.6	71.3	2.87	3.2
	Post- Rep.	491.5	70.8	4.06	2.6
	Mean	**492.53**	**70.76**	**3.62**	**4.2**
Suaeda fruticosa Forssk. ex J. F. Gmelin	Pre- Rep.	460.31	70.5	2.4	4.4
	Reproductive	462.21	71.56	2.1	4.1
	Post- Rep.	464.24	72.38	2.01	4.02
	Mean	**462.25**	**71.48**	**2.17**	**4.17**
Salsola foetida Del.ex Spreng.	Pre- Rep.	391.3	60.11	3.99	2.81
	Reproductive	394.5	58.21	3.05	2.6
	Post- Rep.	396.5	62.32	3.6	2.9
	Mean	**394.1**	**60.21**	**3.54**	**2.77**
Calotropis procera ssp. hamiltonii (Wight) Ali.	Pre- Rep.	610.5	50.11	4.05	3.51
	Reproductive	600	52.12	4.5	4.9
	Post- Rep.	609.53	50.14	4.9	2.99
	Mean	**606.67**	**50.79**	**4.48**	**3.8**
Withania coagulans (Stocks) Dunal	Pre- Rep.	55.3	45.3	3.2	2.8
	Reproductive	65.4	45.3	3.91	1.9
	Post- Rep.	60.4	42.4	3.01	1.01
	Mean	**60.36**	**44.33**	**3.37**	**1.9**

Key: TDN = Total digestible nutrients; DE = Digestible energy; ME = Metabolized energy.

Table 33. Statistical analysis (T-test) for data on various forms of energy in forage plants of District Tank.

Pre- Rep		Reproductive		Post-Rep	
Herbs	Woody	Herbs	Woody	Herbs	Woody
GE					
521.32	440.02	510.51	445.31	490.21	434.54
395.42	552.3	380.41	506.42	412.36	522.3
361.22	490.5	390.32	495.6	395.45	491.5
370.6	460.31	38.5	462.21	365.4	464.24
	391.3		394.5		396.5
	610.5		600.01		609.53
	55.3		65.4		60.4
412.140	**428.604**	**329.935**	**424.207**	**415.855**	**425.573**
5506.08	**32350.2**	**41245.256**	**29046.2**	**2834.32**	**30525.5**
0.8675 NS		**0.4299 NS**		**0.9178 NS**	
DE					
5.6	4.91	6.7	4.5	4.3	3.98
3.3	3.25	2.98	3.25	2.8	3.25
4.5	3.95	3.4	2.87	3.4	4.06
2.4	2.4	2.3	2.1	2.5	2.01
	3.99		3.05		3.6
	4.05		4.5		4.9
	3.2		3.9		3.01
3.950	**3.679**	**3.845**	**3.453**	**4.113**	**7.103**
1.950	**0.645**	**3.828**	**0.794**	**0.180**	**89.114**
0.6867 NS		**0.6526 NS**		**0.4245 NS**	

Pre- Rep		Reproductive		Post-Rep	
Herbs	Woody	Herbs	woody	Herbs	Woody
TDN					
53.41	83.41	54.34	74.52	63.54	61.34
63.83	60.8	72.25	63.51	59.3	66.32
45.3	70.2	43.3	71.3	51.5	70.8
55.3	70.5	55.3	71.56	58.4	72.38
	60.11		58.21		62.32
	50.11		52.12		50.14
	45.3		40.3		52.4
54.46	**62.919**	**56.297**	**61.464**	**58.185**	**62.243**
57.837	**169.541**	**142.748**	**153.151**	**24.885**	**72.799**
0.2708 NS		**0.5031 NS**		**0.4127 NS**	
ME					
4.3	3.92	3.9	2.85	2.63	2.2
4.1	1.98	3.8	1.85	1.98	2.05
3.53	6.8	3.54	3.2	3.52	2.6
4.52	4.4	4.72	4.1	3.66	4.02
	28.1		2.6		2.9
	3.51		3.56		2.99
	1.01		1.9		1.01
4.113	**7.103**	**3.990**	**2.886**	**2.948**	**2.539**
0.18	**89.14**	**0.260**	**0.692**	**0.624**	**0.870**
0.4245 NS		**0.0384 S**		**0.4812 NS**	

Table 34. Cell wall constituents of some forage herbs and woody forage species of District Tank.

Species	Phenological Stage	NDF (%)	ADF (%)	Hemicellulose (%)	ADL (%)
A. Herbs					
Convolvulus arvensis L.	Pre- Rep.	45.41	40.5	11.52	5.61
	Reproductive	33.21	45.3	10.61	6.2
	Post- Rep.	41.22	32.3	10.41	11.5
	Mean	**39.94**	**39.36**	**10.84**	**7.77**
Avena sativa L.	Pre- Rep.	41.89	40.31	8.4	5.41
	Reproductive	40.1	36.21	7.5	5.5
	Post- Rep.	40.3	31.42	6.4	4.31
	Mean	**40.76**	**35.98**	**7.43**	**5.07**
Tribulus terrestris L.	Pre- Rep.	38.5	21.5	5.6	3.2
	Reproductive	41.4	20.5	6.71	3.4
	Post- Rep.	43.5	22.6	7.8	3.2
	Mean	**41.13**	**21.53**	**6.7**	**3.26**
Trifolium alexandrianum L.	Pre- Rep.	51.5	25.4	4.5	2.5
	Reproductive	42.31	26.5	6.5	2.6
	Post- Rep.	44.4	28.3	3.6	3.01
	Mean	**46.07**	**24.73**	**4.86**	**2.7**
B. Woody plants					
Zizyphus mauritiana Lam.	Pre- Rep.	73.5	41.01	15.4	7.1
	Reproductive	66.61	38.5	19.4	6.4
	Post- Rep.	70.2	36.6	21.5	5.3
	Mean	**70.1**	**38.7**	**18.76**	**6.26**
Acacia nilotica ssp. nilotica (L.) Wild. ex Delile	Pre- Rep.	70.31	42.01	13.5	4.5
	Reproductive	71.56	44.02	14.5	4.7
	Post- Rep.	68.57	33.03	11.3	4.9
	Mean	**70.14**	**39.68**	**13.1**	**4.7**

Prosopis cineraria (L.) Druce	Pre- Rep.	73.2	38.34	14.61	5.6
	Reproductive	56.5	35.32	15.53	5.2
	Post- Rep.	75.6	39.335	16.55	5.07
	Mean	**68.43**	**37.66**	**15.56**	**5.29**
Suaeda fruticosa Forssk. ex J. F. Gmelin	Pre- Rep.	61.05	34.5	11.5	5.7
	Reproductive	63.2	35.6	12.1	5.2
	Post- Rep.	65.5	31.6	12.5	4.9
	Mean	**63.25**	**33.9**	**12.03**	**5.26**
Salsola foetida Del.ex Spreng.	Pre- Rep.	56.5	30.5	10.5	3.9
	Reproductive	51.6	25.6	8.5	3.3
	Post- Rep.	60.03	37.7	13.41	3.01
	Mean	**56.04**	**31.16**	**10.8**	**3.4**
Calotropis procera ssp. hamiltonii (Wight) Ali.	Pre- Rep.	42.4	19.4	4.3	6.4
	Reproductive	45.37	21.05	4.5	5.3
	Post- Rep.	48.3	22.22	4.3	5.8
	Mean	**45.35**	**20.89**	**4.36**	**5.83**
Withania coagulans (Stocks) Dunal	Pre- Rep.	55.6	25.7	3.89	4.5
	Reproductive	45.3	26.5	2.56	5.3
	Post- Rep.	43.4	24.5	3.01	6.3
	Mean	**48.1**	**25.56**	**3.15**	**5.36**

Key: NDF = Neutral detergent fiber; ADF = Acid detergent fiber; ADL = Acid detergent lignin

Table 35. Statistical analysis (T- test) of cell wall constituents of herbs and woody plants in District tank.

Pre- Rep		Reproduct		Post-Rep	
Herbs	Woody	Herbs	Woody	Herbs	Woody
NDF					
45.41	73.5	33.21	66.61	41.22	70.2
41.89	70.31	40.1	71.56	40.3	68.57
38.5	73.2	41.4	56.5	43.5	75.6
51.5	61.05	42.31	63.2	44.4	65.5
	56.5		51.6		60.03
	42.4		45.37		48.3
	55.6		45.3		43.4
44.325	**61.794**	**39.255**	**57.177**	**42.355**	**61.657**
30.839	**130.454**	**17.063**	**107.841**	**3.668**	**140.720**
0.0198 S		**0.0101 S**		**0.0023 S**	
Hemicelluloses					
11.52	15.4	10.61	19.4	10.41	21.5
8.4	13.5	7.5	14.5	6.4	11.3
5.6	14.61	6.71	15.53	7.8	16.55
4.5	11.5	6.5	12.1	3.6	12.5
	10.5		8.5		13.4
	4.3		4.5		4.3
	3.89		2.56		3.01
7.505	**10.529**	**7.830**	**11.013**	**7.053**	**11.794**
9.860	**22.171**	**3.620**	**37.379**	**8.059**	**42.244**
0.2857 NS		**0.3464 NS**		**0.2063 NS**	

Pre- Rep		Reproduct		Post-Rep	
Herbs	Woody	Herbs	woody	Herbs	Woody
ADF					
40.05	41.01	45.3	38.5	32.3	36.6
40.31	42.01	36.21	44.02	31.42	33.03
21.5	38.34	20.5	35.32	22.6	39.35
25.4	34.5	26.5	35.6	28.3	31.6
	30.05		25.6		37.7
	19.4		21.05		22.22
	25.6		26.5		24.5
31.815	**32.987**	**32.127**	**32.370**	**28.655**	**32.143**
95.844	**70.755**	**119.016**	**66.811**	**19.240**	**43.441**
0.8382 NS		**0.9673 NS**		**0.3739 NS**	
ADL					
5.61	7.1	6.2	6.4	11.5	5.3
5.41	4.5	5.5	4.7	4.31	4.9
3.2	5.6	3.4	5.2	3.2	5.07
2.5	5.7	2.6	5.2	3.01	4.9
	3.9		3.3		3.01
	6.4		5.3		5.8
	4.5		5.3		6.3
4.180	**5.386**	**4.425**	**5.057**	**5.505**	**5.040**
2.447	**1.315**	**2.896**	**0.863**	**16.302**	**1.066**
0.1733 NS		**0.4374 NS**		**0.8261 NS**	

Key: NDF = Neutral detergent fiber; ADF = Acid detergent fiber; ADL = Acid detergent lignin

ETHNOBOTANY

ETHNOBOTANY

A. Fuel Wood

Information about the respondents

Of the total respondents, 360 were male (96%) and 15 were female (4%). Most of them (50%) were in the age of 41-60. Most were either illiterate (35%) or had primary (27%) education (Table 36).

Amount of wood harvested and consumption

It was estimated that a total of 3652 metric tons of wood was harvested annually from six investigated locations for fuel purposes. Statistically the differences among the sites were insignificant (Table 37).

The amount of wood consumed was estimated by the relative number of respondents involved in wood harvesting to the total amount of wood harvested/removed which were more or less equal except that of town where the removal was negligible. Table 38 shows that the total amount of wood consumed for fuel purposes in different locations was 18371 metric tons per year. ANOVA values showed insignificant differences in amount of wood consumed in the areas at alpha (0.05). However, significant differences at alpha (0.05) existed between the mean annual harvest and consumption of wood in the area. The mean annual removal and consumption of wood in Warana station was highest compared to rest of the five stations due to presence of abundance brick kilns which consumed large amount of fuel wood (Table 39). All the respondents (100%) told that there is no check or law preventing the existing deforestation due to ownership of the land that no one can stop them from utilizing these resources. Due to poverty, lack of education and no alternative for fuel wood, use of vegetation remains the only and most common choice to use as fuel wood in the study area. Deforestation has not only promoted soil erosion (Fig. 4) but also has caused loss of local fauna in the area. A similar situation in Rajistan India (Nagothu *et al*., 2001), in Bangladesh (Danesh *et al*., 2009) and in Sudan (Alam & Starr, 2009) has been reported for deforestation and loss of flora and fauna. The quantity of wood consumed outweighed the quantity harvested in the area. The deficiency of 15398.5 metric tons/year is compensated by the neighboring forest of Tehsil Kulachi and Dera Ismail Khan (Table 39). Our findings agree with Ogunkunle & Oladele (2004) and Bensel (2008) who

reported similar results from Nigeria and Philippines, respectively. Rawat *et al.* (2009) stated that fuel wood consumption among the tribal communities in cold desert of the Lahaul valley, India was extremely high and the people have to rely on local flora for their fuel energy.

The total annual consumption of fuel wood being 18373 metric tons/year was extracted from twenty five species (Table 40). All (100%) of the house hold used fuel wood for domestic cooking as no alternate fuel energy is available. Similarly, Hulscher & Ambiog (2000) concluded that the demand for fuel wood can only be met by overexploiting forests, and that numerous developing countries including Bangladesh, China, India, Pakistan, and Thailand are already doing just that. Same is the case in the present study. Some 13650 metric tons/year of timber wood was utilized from ten species in the study area, showing that reliance of people in the area on the forest for most of their timber requirements. Similar results were reported by Saqib *et al.* (2002) and Shah *et al.* (2007) from other area in Pakistan which supports the present results.

Ranking and criteria for considering best fuel wood

The respondents prioritized the best fuel wood species in the area. Among them, *Acacia nilotica ssp. nilotica* was frequently used for fuel wood. This is due to its high heat value (50%) as fuel, which made it the best species (Table 41). *Tamarix aphylla* and *Suaeda fruticosa* is extensively used as fuel wood because of abundant growth (24%), easy collection and light in transportation as a head load. *Prosopis cineraria*, *Zizyphus nummularia*, *Phoenix dactylifera*, *Tamarix dioica* and *Prosopis farcta* was next extensively used fuel wood in the area. The interviewee considered *Acacia nilotica* ssp. *nilotica* as the best timber wood and fuel wood species due to its durability and high heat value. Badshah *et al.* (2006), Barkatullah *et al.* (2009) and Hartter & Boston (2008) stated that most of these species were preferred for fuel wood and therefore were under heavy stress similar to present findings. *Prosopis farcta* was commonly used for timber purpose and seldom as fuel wood due to smoky fire. It is less available in the area. *Tamarix aphylla* and *Suaeda fruticosa* respectively are efficient fuel plants because of their abundantly growth and occurrence.

Virtually any woody species is being used as fuel wood in the study area. *Prosopis cineraria*, *Euclaptus glubulus*, *Salsola foetida*, *Tamarix dioica* and *Zizyphus*

nummularia were also popular fuel wood species in the area. Ali & Benjaminsen (2004) observed that increased human population has resulted in increased demands for natural resources, leading to severe resource depletion, especially deforestation for fuel and timber wood in Siran valley Pakistan which is in line with the present study. The low proportion of forest land and continuing degradation of existing forest cover are serious threats to the sustainability of forestry in Pakistan (Muhammad & Chris, 2006) which is also true in the present study.

B. Timber Wood

Information about the respondents

The total respondents, 360 were male (96%) and 15 were female (4%). Most of them (50%) were in the age of 41-60. They were either illiterate (35%) or had primary (27%) education (Table 36).

Amount of timber wood consumption

It has been estimated that a total of 12870 metric tons of wood is harvested annually from six investigated locations for timber purposes. Statistically the differences among the sites were insignificant (Table 37).

This was also estimated by the relative number of respondent involved in wood harvesting to the total amount of wood harvested/removed which were more or less equal except that of town where the removal was negligible. Table 38 showed that the total amount of timber wood consumed in different locations was 13650 metric tons per year. ANOVA values did not show any significant differences in amount of wood consumed in the area at alpha (0.05). However, significant differences at alpha (0.05) existed between the mean annual harvest and consumption of wood in the area (Table 39). The mean annual removal and consumption of wood in Warana station was highest compared to rest of the five stations due to operation of several saw machines. Likewise 13650 metric tons of timber wood was utilized from ten species in the study area, which showed that people in the area even in this modern age mostly rely on forest for most of their timber purposes (Table 40).

Ranking and criteria for considering best timber wood

The respondents also prioritized the best timber wood species in the area. Among them *Acacia nilotica ssp. nilotica, Prosopis farcta* and *Dalbergia sissoo* were considered

as the best timber wood in the area. The criteria considered was its durability (43%), straight pole habit (39%) and toughness (19%) (Table 41). The other rarely used timber species were *Tamarix aphylla*, *Euclaptus glubulus, Phoenix dactylifera, Morus alba* and *Zizyphus mauritiana* etc.

On the whole, an estimated 32021 metric tons/year of wood was used for both as fuel and timber wood in District Tank. Our findings are similar to those of Ogunkunle & Oladele (2004) who stated that the rural area of Obomosa, Nigeria utilized and consumed about 85873 metric tons of fuel and timber wood every year. The rapidly decreasing forest due to timber, fuel and over grazing, the land is becoming barn and less productive resulting into habitat loss. This adversely affect land productivity and hence the local and national economy. Miah *et al*. (2009) in Bangladesh showed that family size, income, amount cooked and burning hours significantly affected the amount of wood fuel used per family/year. He stated that each family consumed 4.24 tones fuel wood/year which satisfied our findings. *Dalbergia sissoo* is costly and used only as furniture wood. Pasiecznik *et al*. (2006) stated that different trees like *Dalbergia sp.* converted into various timber purposes in UK which strengthen our findings. *Tamarix aphylla, Euclaptus globulus, Phoenix dactylifera, Morus alba* and *Zizyphus mauritiana* were less preferred timber species in the area.

Table 36. Level of knowledge by age group and education level about fuel and timber plants in District Tank.

Age group	**No of plants known**			
(Years)	Up to 2	3- 4	+ 5	Total
Up to 20	3	-	-	3
21 – 40	10	7	-	17
41 – 60	5	5	40	50
61 – 80	-	2	28	30
Total	18	14	68	100
Education level				
Illiterate	2	10	23	35
Primary	3	6	18	27
Middle	5	5	13	23
Matric	5	-	-	5
FA/ F.Sc	4	-	3	7
BA /B.Sc	-	2	-	2
MA/M.Sc	1	-	-	1
Total	20	23	57	100

Table 37. Wood harvested from forest for fuel and timber purposes in metric ton yr^{-1} (Number of respondents is shown in parenthesis) in district Tank.

Harvesting mode	Location / sites						
	Town city	Warana	Gul Imam	Ranwal	Dabara / Gomal	Umar Ada	Total
1. Tree feller and tree cutter	-	3900 (10)	2770 (7)	3120 (8)	1950 (5)	1170 (3)	**12,870 (33)**
2. Farmers	-	5.5 (11)	10 (20)	12.5 (25)	15 (30)	17.5 (35)	**60.5 (121)**
3. Fuel wood seller	156 (3)	260 (5)	780 (15)	676 (13)	1092 (21)	728 (14)	**3,692 (71)**
Total	**156 (3)**	**4165.5 (26)**	**3520 (42)**	**3808.5 (46)**	**3057 (56)**	**1926 (52)**	**16,622.5 (225)**

Table 38. Consumption of fuel and timber wood in metric ton yr^{-1} in District Tank (Number of respondents is shown in parenthesis)

Consumption mode	Town city	Warana	Gul Imam	Ranwal	Dabara / Gomal	Umar Ada	Total
1. Brick brewers/ backing	6000 (10)	4800 (8)	2400 (4)	1800 (3)	1200 (2)	600 (1)	*16800 (28)
2. Fire wood							
a. Food seller (Thandor owner)	520 (20)	-	52 (2)	-	182 (7)	130 (5)	*882 (34)
b. Domestic / households cooking	130 (10)	117 (9)	91 (7)	104 (8)	130 (10)	117 (9)	*689 (53) *18371
3. Machine saw	5850 (15)	1950 (5)	1560 (4)	780 (2)	2340 (6)	1170 (3)	13650 (35)
Total	**12500 (55)**	**6867 (22)**	**4103 (17)**	**2684 (13)**	**3852 (25)**	**2017 (18)**	**32021 (150)**

Table 39. Mean estimated quantity of wood harvest and wood consumed (metric tons yr $^{-1}$) in District Tank.

S. No.	Localities / Sites						
	Town city	Warana	Gul Imam	Ranwal	Gomal	Umar Ada	Total
Wood removed	52	160	84	83	55	37	471
Wood consumed	227	312	241	206	154	112	1,252

Table 40. Frequency utilization (%) of the plants species harvested for fuel and timber wood in District Tank.

No.	Scientific name	Local name	Family	% frequency	
				Fuel wood	Timber wood
1.	*Acacia modesta* Wall	Palosa	Mimosaceae	0.8	2.8
2.	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	Kikar	Mimosaceae	86.9	88.5
3.	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	Sperai	Amaranthaceae	3.4	-
4.	*Brassica rapa ssp. campestris* (L.) Clapham	Usoon	Brassicaceae	0.8	-
5.	*Calotropis procera ssp. hamiltonii* (Wight) Ali	Spulmaka	Asclepiadaceae	1.7	-
6.	*Capparis decidua* (Forssk.) Edgew.	Kira	Capparidaceae	6.1	2.8
7.	*Celtis eriocarpa* Decne.	Thogh therawan		0.8	-
8.	*Cymbopogon jwarancusa* (Jones) Schult.	Sargaray	Poaceae	0.8	-

9.	*Dalbergia sissoo* Roxb.	Sava	Papilionaceae	4.3	28.5
10.	*Dodonaea viscosa* (L.) Jacq.	Zerawanay	Sapindaceae	0.8	-
11.	*Eucalaptus glubulus* Labill	Sufaida	Myrtaceae	30.4	17.4
12.	*Ficus carica* L.	Anger/ thogha	Moraceae	0.8	-
13.	*Melia azedarach* L.	Dahark	Meliaceae	1.7	-
14.	*Morus alba* L.	Toor toot	Moraceae	6.1	5.7
15.	*Morus nigra* L.	Spin toot	Moraceae	-	5.7
16.	*Phoenix dactylifera* L.	Kajoor	Palmaea	13.9	8.5
17.	*Prosopis cineraria* (L.) Druce	Kikray	Mimosaceae	44.3	-
18.	*Prosopis farcta* (Banks & Sol.) Macbride	Niskora	Mimosaceae	42.6	17.4
19.	*Salvadora oleoides* Decne.	Pleman	Salvadoraceae	4.3	-
20.	*Salsola foetida* Delile ex Spreng.	Lanrhay	Chenopodiaceae	9.5	-
21.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	Zamay	Chenopodiaceae	61.7	-
22.	*Tamarix aphlla* (L.) Karst	Ghaz	Tamaricaceae	89.5	14.2
23.	*Tamarix dioica* Roxb. ex Roth.	Sarghaz	Tamaricaceae	35.6	-
24.	*Typha latifolia* L.	Lokha / dela	Typhaceae	8.6	-
25.	*Zizyphus mauritiana* Lam.	Bera	Rhamnaceae	52.1	20.0
26.	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	Karan bera	Rhamnaceae	2.6	-

Table 41. Criteria for considering best fuel and timber wood species as told by the best by locals.

Criteria	A. Fuel wood species		
	Acacia nilotica ssp. nilotica (L.) Wild. ex Delile	*Tamarix aphylla* (L.) Karst	*Suaeda fruticosa* Forssk. ex J. F. Gmelin
High heat value	50	15	-
Easy availability	20	8	-
Less Smoky	10	-	-
Durable continuous flame	8	-	-
Rapid growth	12	15	-
Early drying	-	-	10
Inflammable	-	-	15
Easy to collect	-	30	25
Light weight	-	-	30
Abundant growth	-	24	-
Non spiny	-	8	-
Easy regeneration	-	-	20
Criteria	**B. Timber wood species**		
	Acacia nilotica ssp. nilotica (L.) Delile	*Prosopis farcta* Banks & Sol.) Macbride	*Dalbergia sissoo* Roxb.
Durable wood	43	21	20
Rapid growth	13	-	-
Self regeneration	10	-	-
Resistant to termite attack	15	10	8
Utility as furniture	-	-	31
Attractive appearance	-	14	41
Toughness	19	-	-
Straight pole habit	-	39	-
Wood planking easy	-	16	-

C. Fodder Plants

Fodder for ruminant feeding are generally defined as the plant materials, primarily leaves and stems, whole plant wild or grown for either direct consumption by ruminant or preserved for feeding of such animals (Heady, 1964). Hence the amount of forage available and consumable per unit area of land will support a certain number of livestock. Willms *et al*. (1998) suggested that for improving forage production, it is important to choose those plant/fodders which have high net primary productivity to support large number of live stock for better animal products.

Information about the respondent

Majority of the respondents were in the age group of 61- 80 years (41%) followed by 41- 60 years (30%). Many of them were either illiterate (53%) or had got their primary education only (22%). The respondents of age group from 60 and above were more knowledgeable, who knew up to 10 fodder plants. Most of the respondent (46%) listed up to 9 plants, while (35%) of them spoke up to 8 plants (Table 42).

Listing of fodder plants

Forty species of plants are frequently used as fodder in District Tank (Table 43). However, respondents could list only 12 species during free listing. *Acacia nilotica ssp. nilotica* and *Zizyphus mauritiana* were listed respectively by 100% and 90% of the respondents. The locals listed both these species at first three positions. *Convolvulus arvensis, Trifolium alexandrianum* and *Suaeda fruticosa* were the second frequently used fodder species, which was listed respectively by 85%, 80%, and 60% of the interviewee. *Salsola foetida* and *Brassica compestris* were also preferred fodder species, which was listed by 60% and 45% of the respondents, respectively. *Tribulus terrestris* and *Zea mays* were recommended by less than 50% of the respondents. The remaining species were listed by either 30% or less than 30% of the respondents (Table 44).

Ranking the best fodder species

Of the 40 recorded species, only 12 species viz: *Acacia nilotica ssp. nilotica, Zizyphus nummularia, Convolvulus arvensis, Trifolium, Salsola foetida, Suaeda fruticosa, Brassica compestris, Tribulus terrestris, Zea mays, Triticum aestivum, Prosopis cineraria* and *Tamarix aphylla* were considered as the best fodder plants in the area. *Acacia nilotica, Zizyphus mauritiana* and *Convolvulus arvensis,* were the most

preferred species in the area. The respondents were asked to rank the three best species in the area (Table 45). *Acacia nilotica ssp. nilotica*, *Zizyphus mauritiana* and *Convolvulus arvensis* were ranked as the three best fodder species by 100%, 90% and 85 of the respondent, respectively.

Criteria used for ranking the best fodder species

The criteria used for ranking the best fodder included the ever green nature, easy availability, storage capability, ability to induce milking and to provide nutritious values.

1. *Acacia nilotica ssp. nilotica*

Thirty percent of the respondents considered it as the best fodder species due to its high nutritious value, improving fatting in cattle followed by its easy availability (25%). Drought resistance and ever green nature (20%), highly palatability (15%) and agreeable taste (10%) were some other reasons for considering it as the best fodder (Table 46).

2. *Zizyphus mauritiana*

Zizyphus mauritiana was considered as the second best fodder species due to high preference by livestock (40%), improving fertility (31%) and ever green nature (23%). Few people considered it as a nutritious plant (6%) (Table 46).

3. *Convolvulus arvensis*

An increase in milk production (by 35%), good storage (30%) agreeable taste (20%) and nutritious value (by 15%) were the main criteria for considering it as the third best fodder in the area (Table 46).

It was interesting to note that *Acacia nilotica ssp. nilotica* and *Zizyphus mauritiana* were not only considered as the best fodder plants but also declared as the best fuel and timber wood species in the area. This definitely means a lot of human and grazing pressure on them. The findings agree with those of Hussain & Durrani, (2009a) who also reported that species with high nutritive values were preferred over others in Harboi range lands Kalat, Pakistan. Similarly, Samant *et al.* (2007) listed 150 fodder species of fodder including trees, shrubs and herbs for livestock in the Indian Himalayan Region with varying palatability. Some of the species viz. *Capparis decidua*, *Zizyphus* and *Saccharum spontaneum* are common to our findings. They also ranked plants on the basis of criteria similar to ours. Generally, men harvest fodder in range lands of District Tank and transport it as head load to their houses. The fodder is used both in fresh and

dried form. This agrees with the findings of Galli *et al*. (2006) who stated that some species were used as fresh and dried fodder in Argentina. Barkatullah *et al*. (2009) also reported that some plants were most preferred by animals over others species in Malakand division Pakistan. Likewise, Mazancourt & Loreau (2000) stated that grazing optimization occurs when herbivory increases primary production at low grazing intensities. This threshold changes with plant community composition and herbivore preference and is, therefore, strongly affected by plant species replacement.

There is great pressure on the vegetation due to heavy grazing as the nomads move their cattle to higher elevation in summer and return back on the arrival of winter through these semiarid rangelands (Fig 5). Therefore, both the regenerating season i.e. spring and autumn is under severe grazing and browsing stress due transhumunscence. Boone *et al*. (2007) also stated that in semi-arid tropical sites in USA, water and forage shortages in the dry season cause pastoral livestock to move to water or key resource areas. In temperate summers, livestock may be moved to higher elevation snow free meadows. In winters, animals may be moved down to warmer sites, or to mountain valleys protected from steppe winds. Some 300 species of grasses, other herbaceous plants, trees and shrubs were found in the mid-altitude rangelands of Uttarakhand, India, which are used as fodder for both in fresh and dried condition (Singh *et al*., 2008).

It was observed that species like *Acacia nilotica*, *Zizyphus nummularia* and *Tamarix aphylla* served as fodder throughout the year when no alternative feed was available. Therefore they are severely grazed and possessed much adapted potential. Similarly Gherbin *et al*. (2007) observed that Warm-season grasses and legumes have the potential to provide forage throughout the Mediterranean summer when there were high temperatures and low rainfall and when cool-season grasses become less productive.

On the whole, there is always shortage of the fodder in the range land of District tank. This is due over stalked livestock and unmanaged grazing system in the area. Plants are heavily grazed round the year and most of the palatable species have assumed bushy or cushion like habit (Fig 6). The regeneration capacity has declined as the plants are being grazed even before flowering and fruiting stage. Furthermore, the camels were abundant in the area and have an easy access to bushes, trees and herbs (Fig. 7). This modified the vegetation into bushy land with stunted plants. The grazable plants also

serve as medicinal, fuel and timer wood species. This multidirectional pressure hardly provides any chance to these plants to regrowth after grazing or lopping.

Similar study (Gallacher & Hill, 2008) conducted in Dubai, showed that heavy browsing by camel reduced species richness and diversity of trees shrubs without significantly reducing seedling density, which are in agreement to our work. Since the local depends on livestock for their livelihood they therefore cannot avoid these practices of keeping and rearing cattle and herds. There is need to improve the range lands grazing management practices. A poor quality livestock breed will consume more and return less (Fig. 8). For this reasons the locals keep large number of livestock to earn more at the cost of vegetation depletion. The pressure on range lands resources can be reduced if high yielding breeds of livestock are provided to the locals. These might met the demands of locals and reduce the grazing pressure.

Animal preferences

According to the locals *Acacia nilotica ssp. nilotica* was highly preferred by goat (60%) and camels (25%), respectively. Cows (5%) and sheep (10%) rarely preferred it owing to spiny nature (Table 6). Similarly, *Zizyphus mauritiana* was also preferred by goats (50%) and camel (30%). Sheep (20%) grazed rarely when no other alternative feed was available (20%). Cow did not like it. *Convolvulus arvensis* was preferred by cow (45% respondents) and sheep (35%). Goat and camel rarely prefer this fodder (Table 47).

Table 42. Level of knowledge about fodders among the respondents in different age and education groups.

Age group	**Number of plants known to inhabitant**				
	Up to 3	4- 6	7 – 8	9 -10	Total
Up to 20	3	-	-	-	3
21 -40	-	15	11	-	26
41 – 60	-	-	14	16	30
61 – 80	-	-	11	30	41
Total	3	15	36	46	100
Education					
Illiterate		10	22	21	53
Primary	3		10	9	22
Middle	5	5	-	-	10
Matric	5	-	-	-	5
FA/ F.Sc		-	3	-	6
BA /B Sc	-	2	-	-	2
MA/M.Sc	2	-	-	-	2
Total	18	17	35	30	100

Table 43. List of forage species as identified by the locals and herdsman in District Tank.

No.	Botanical Name	Local name	Family
1.	*Avena sativa* L.	Karyanrha	Poaceae
2.	*Aerva javanica* (Burm.f.) Juss.ex J.A. Schult.	Sperai	Amaranthaceae
3.	*Anagallis arvensis* L.	Gul boti	Primulaceae
4.	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	Kikar	Mimosaceae
5.	*Brassica rapa ssp. campestris* (L.) Clapham	Osogan	Brassicaceae
6.	*Chenopodium album* L.	Sarmay	Chenopodiaceae
7.	*Chenopodium murale* L.	Tor sarmay	Chenopodiaceae
8.	*Convolvulus arvensis* L.	Parwati	Convolvulaceae
9.	*Cymbopogon jwarancusa* (Jones) Schult.	Sargharay	Poaceae
10.	*Capparis decidua* (Forssk.) Edgew.	Kreta	Capparidaceae
11.	*Cynodon dactylon* (L.) Pers.	Am washa	Poaceae
12.	*Centaurea iberica* Trevir. ex Spreng.	Azghai	Asteraceae
13.	*Cicer arietinum* L.	Chanrha	Papilionaceae
14.	*Calotropis procera ssp. hamiltonii* (Wight) Ali	Splmaka	Asclepiadaceae
15.	*Desmostachya bipinnata* (L.) Stapf.	Drab	Poaceae
16.	*Dalbergia sissoo* Roxb.	Shawa	Papilionaceae
17.	*Centaurium pulchellum* (Sw.) Druce	Sur gulay	Gentianaceae
18.	*Fagonia indica* var. *schweinfurthii* Hadidi	Spelaghzay	Zygophyllaceae
19.	*Heliotropium europaeum* L.	Waghi	Boraginaceae
20.	*Lathyrus aphaca* L.	Mater	Papilionaceae
21.	*Lathyrus sativus* L.	Matri gul	Papilionaceae
22.	*Melilotus alba* Desr.	Shinji	Papilionaceae
23.	*Morus alba* L.	Spin tot	Moraceae
24.	*Medicago polymorpha* L.	Shpathlary	Amaranthaceae
25.	*Malva parviflora* L.	Pachkay	Malvaceae
26.	*Malva neglecta* Wallr.	Tiklay	Malvaceae

27.	*Oxalis corniculata* L.	Tarwekaai	Oxalidaceae
28.	*Oryza sativa* L.	Sholay	Poaceae
29.	*Rumex dentatus* L.	lablabo	Polygonaceae
30.	*Sonchus asper* (L.) Hill	Kandiari	Asteraceae
31.	*Salsola foetida* Del. ex Spreng.	Lanrhay	Chenopodiaceae
32.	*Sisymbrium irio* L.	Jungl usson	Brassicaceae
33.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	Tor lanrhay	Chenopodiaceae
34.	*Tribulus terrestris* L.	Maklinday	Zygophyllaceae
35.	*Tamarix aphylla* (L.) Karst	Ghaz	Tamaricaceae
36.	*Torilis japonica* (Houtt.) DC.	Spin gulay	Apiaceae
37.	*Triticum aestivum* L.	Kanrak	Poaceae
38.	*Trifolium alexandrianum* L.	Shaftal	Papilionaceae
39.	*Zea mays* L.	Jowar	Poaceae
40.	*Zizyphus mauritiana* Lam.	Bera	Rhamnaceae

Table. 44. Ranking of fodder plants by locals of District Tank.

S.No	Species	Total	No of species listed by locals									
			1	2	3	4	5	6	7	8	9	10
1.	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	100	59	30	11	-	-	-	-	-	-	-
2.	*Zizyphus mauritiana* Lam.	90	49	41	-	-	-	-	-	-	-	-
3.	*Convolvulus arvensis* L.	85	34		30	21	-	-	-	-	-	-
4.	*Trifolium alexandrianum* L.	80	40	40	-	-	-	-	-	-	-	-
5.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	60	-	-	-	25	-	30	-	5	-	-
6.	*Salsola foetida* Del.ex Spreng.	60	-	-	30	-	15	-	-	10	-	5
7.	*Brassica rapa ssp. campestris* (L.) Clapham	50	-	15	10	-	-	25	-	-	-	-
8.	*Medicago polymorpha* L.	45	-	27	-	-	-	-	15	-	3	
9.	*Zea mays* L.	40	-	-	-	-	13	-	-	20	-	7
10.	*Triticum aestivum* L.	30	18	-	-	-	12	-	-	-	-	-
11.	*Prosopis farcta* (Banks & Sol.) Macbride	30	-	-	-	-	-	6	-	22	-	-
12.	*Tamarix aphylla* (L.) Karst	10	-	-	-	-	-	-	5	-	-	5

Table 45. Ranking the three best fodder species by respondents (%).

Species	Total	Age groups (Years)			
		Up to 20	21- 40	41- 60	61- 80
Acacia nilotica ssp.niolotica (L.) Wild. ex Delile	100	20	25	46	9
Zizyphus mauritiana Lam.	90	5	30	35	30
Conolvulus arvensis L.	85	5	28	34	18

Table 46. Criteria considered by the locals for ranking the three best fodder species (%).

Criteria	Species		
	Acacia nilotica ssp. nilotica	*Zizyphus mauritiana*	*Convolvulus arvensis*
Nutritious	30	06	15
Enhances fertility	-	31	-
Ever green nature	20	23	-
Increases milking capacity	-	-	35
Easy availability	25	-	-
Good storage	-	-	30
Highly palatability	15	40	-
Agreeable taste	10	-	20

Table 47. Animal preferences of various fodders as stated by the locals (%).

Livestock	Fodder plants		
	Acacia nilotica ssp. nilotica	*Zizyphus mauritiana*	*Convolvulus arvensis*
Goat	60	50	15
Cow	05	-	45
Camel	25	30	05
Sheep	10	20	35

D. Medicinal Plants

Knowledge and ranking of the medicinal plants

A total of 375 respondents belonging to various age groups were interviewed. Majority of the respondents were in the age group of 41- 60 (50%) and 61-80 (30%) and were mostly illiterate (35%) or with primary education (27%) were more knowledgeable than younger age groups. The majority of the respondent (68%) knew at least 5 medicinal plants (Table 48).

Listing of the medicinal plant

A total of 41 species were valued of as medicinal importance (Table 49). Among them eleven species; *Citrullus colocynthis*, *Fagonia indica* var. *schweinfurthii*, *Withania coagulans*, *Periploca aphylla*, *Peganum harmala*, *Salvadora oleoides*, *Solanum suartense*, *Calotropis procera*, *Suaeda fruticosa*, *Alhagi maurorum* and *Malva parviflora* were frequently used as medicinal plants in the investigated area. *Citrullus colocynthis*, *Fagonia indica* Var. *schweinfurthii* and *Withania coagulans* were listed, respectively by 100%, 90% and 70% of the respondents at first three positions. *Periploca aphylla*, *Peganum harmala* and *Salvadora oleoides* were the second most frequent useful species listed respectively by 65%, 60% and 50% of the respondents (Table 50). They were listed up to 5th positions. *Solanum surattense*, *Calotropis procera* and *Suaeda fruticosa* were also popular medicinal plants which were listed by 50%, 45% and 30% respondents in the area. *Alhagi maurorum* and *Malva parviflora* were listed by less than 20% of the interviewees (Table 50).

The use of medicinal plants is still trusted in the local health care system in the traditional societies. The study revealed that the local of District Tank use some 41 medicinal plants in their daily life for curing various diseases. It was observed that young sect of the respondent up to 20 years of age had poor knowledge than the elderly age groups who at least listed more than 9 species. Hussain *et al*. (2006) and Perveen *et al*. (2007) reported that elderly respectively in South Waziristan, Pakistan and in Thar desert, India were more knowledgeable than young populations about medicinal plants. Our results also showed that 80% of the respondents were of elderly age. The growing young population is either less aware about traditional medicinal system or they have given up the use of medicinal plants in favor of quick remedy. Our findings agree with those of

Ahmad *et al*. (2009a) who reported 89 plants of therapeutic use in Siran valley, Hazara. Likewise, Ahmad & Hussain (2008) reported that local communities of Kallar Kahar, Pakistan have rich tradition of using 29 natural plant resources for their common day ailments. The data recorded during this study were compared with the related literature Bhattarai *et al*. (2009), Pattanaik & Sudhakar (2008), Ahmad *et al*. (2006), Tene *et al*. (2007) and Kultur (2007) and it was found that most of these plants are already known for similar uses. However, their recipes added ingredients and the methods of preparation use in the majority of cases are different.

Ranking the best medicinal plants

The respondents ranked 11 species as the most important medicinal plants of the area. They are being used for treating gastric troubles, constipation, and stomachache, carminative, cough and wound healing. The local preparation/recipe was generally named either after diseases cured or after plant used. In other parts of the world, too, the organoleptic properties such as bitter, sweet, aromatic and sour were used to recognize plants (Wiemann & Heiunch 1998). *Citrullus colocynthis* with various medicinal uses was ranked as the most important plant of the area by 100% of the respondents. *Withania coagulans* and *Fagonia indica* var. *schweinfurthii* was respectively the second and third best medicinal plants recognized by 90% and 80% of the respondents. The locals and health practitioners valued *Citrullus colocynthis* (100%), *Withania coagulans* (90%) and *Fagonia indica* var. *schweinfurthii* (80%) as the three best medicinal species in the area (Table 50).

Criteria for considering the best medicinal plants

1. ***Citrullus colocynthis:*** It was vetted as the best medicinal plant by 100% of the respondents for its utility to treat constipation (50%), biliousness (30%) and as stomachache (by 20%) (Table 51).

2. ***Witthania coagulans:*** It was ranked as the second best medicinal plant by 90% of the interviewee owing to its ability to improve digestion (by 55%), cooling agent (by 30%) and as remedy for constipation (by 10%) (Table 51).

3. ***Fagonia indica* var. *schweinfurthii:*** It was ranked as the third best medicinal herb owing to its ability to treat dyspepsia (55%), anthelmintic (by 30%) and as blood purifier (by 15%) (Table 51).

The criteria used for ranking the medicinal plant included elimination of worm, blood purification, biliousness, stomachache, gastric trouble and curing constipation. Many other studies have also reported similar findings (Wondimu *et al.*, 2007; Muthu *et al.*, 2006; Mugisha *et al.*, 2007; Tardio *et al.*, 2006; Olsen & Larsen 2003). None of the medicinal plant is sold in the local market. All these plants were used as home remedies. It was emphatically noted during the survey of medicinal plants of District Tank, that the healers now represent a disappearing oral tradition the knowledge is not passed on to the next generation. This is because the younger generation usually considers the belief in plant remedies a sort of superstition and less effective compared to modern medicine. Moreover, modern medical facilities are now making their way into these traditional medicines. So, the folk faith on medicinal plants is now disappearing. It was therefore, considered important that this valuable knowledge regarding folk medicinal uses of plants be recorded before such valuable knowledge is lost forever. There are dwindling number of local healer and indiscriminate use of plants leading to rapid loss of many plant species. Perveen *at al.* (2007) reported similar result from the rural people of India. The area is basically semi desert, where the protection to medicinal plants is not affordable because of heavy deforestation and overgrazing (Badshah *et al.*, 2010b) and (Hussain & Durani, 2009a) and (Hussain & Badshah 1998). Plant identified as medicinal were frequently used as timber, fire wood and grazing purposes (Fig. 9). With partial improvement of socioeconomic status and more facilities the dependence on traditional medicinal plant health care system has declined and has shifted in favor of modern health care system.

There is need to conserve not only the medicinal plants but the centuries old knowledge, which is declining fast. The result of this study suggests that the medicinal plants that are declining should be the primary concern to cultivate and protect from being harvested and alternate source to fuel wood (Fig. 10) be provided to reduce pressure on natual vegetation. Further study is needed to see the conservation status of the medicinal plants in the area.

Folk uses of the medicinal plants

The scientific, local names, plant parts local drug preparation, diseases treated and administration of 41 species reported as medicinal plants are briefly stated as follows:

1. *Acacia nilotica* ssp. *nilotica* (Family Mimosaceae; Local name; kikar). Fresh root extracts are used as narcotic, known as Desi sharab (local bear). Fifteen gm fresh leaves are soaked in sufficient hot water for 12 h to get the extract, which exhibits alcoholic property. Four gm of gum acacia is taken with a glass of water once a day as aphrodisiac; branches are used as a miswak (local tooth brush) due to its germicidal and antimicrobial activities for cleaning teeth.
2. *Achyranthus aspera* (Family Amaranthaceae; Local name; Rinzak). The extracts form boiled roots is taken half cup twice a day for expulsion of kidney stone. Leaf paste is useful against bee sting; decoction of fruits is given for toothache and stomachache.
3. *Aerva javanica.* (Family Amaranthaceae; Local name; Sperai). Relieves headache and rheumatism.
4. *Alhagi maurorum* (Family Papilionaceae; Local name; Thandha). The exudation from leaves and branches is used once a day as blood purifier and as expectorant; twenty gm dried powdered roots are taken once a day for two weeks with water for relieving kidney troubles.
5. *Allium cepa* (Family Alliaceae; Local name; Piaz). The onion bulbs wrapped in cloth are worn like a necklace to treat whooping cough. It serves as spice and condiment.
6. *Allium sativum* (Family Alliaceae; Local name; Wozha). Small piece of *Allium sativum* chewed twice a day control blood pressure. It is also used as laxative, digestive and carminative.
7. *Amaranthus viridis* (Family Amaranthaceae; Local name; Banar). A tea spoonful of crushed seeds and leaves are crushed with sugar is taken 4 times a day with black tea for curing constipation in children.
8. *Anagallis arvensis* (Family Primulaceae; Local name; Ghandi boty). Two gm dried powdered shoots are mixed with 5 gm wheat flour to make past which is used once a day for a week to treat rheumatism and inflammations.

9. *Calotropis procera* ssp. *hamaltonii* (Family Asclepiadaceae; Local name; Spalmaka). Crushed leaves are used as bandages to heal rheumatic joints and swelling. Milky latex is used to extract broken thorn and spines from body parts. The past from inflorescences is tied over the breast to shape them beautifully.
10. *Capparis decidua* (Family Capparidaceae; Local name; Kirrah).Young shoots are used as plaster for boils and swelling. Crushed shoots and fruits mixed in mustard oil are applied once a day for healing swelling. Fruits are laxative and also used in making pickles and jams.
11. *Chenopodium murale* (Family Chenopodiaceae; Local name; Tora sarmay). Whole plant is dried, chopped and boiled in water. Half glass of extract is taken daily to regulate the menstrual flow. The decoction from leaves is recommended for treatment of skin disorders.
12. *Chenopodium album* (Family Chenopodiacea; Local name; Sarmay). Shoots are soaked in a glass of cold water for 2-4 hour and filtered to get extract, which is drunk twice a day to remove kidney pain. Sometime, half of this extract is mixed with an equal volume of aqueous extracts from corn hair and used for removing kidney stones.
13. *Citrullus colocynthis* (Family Cucurbitaceae; Local name; Ghata maraghone). The powdered fruits are mixed with natural honey to prepare tharkha Hallwa. Two or 3 teaspoonful of this recipe is taken three times a day for curing stomachache and expulsion of round worms.
14. *Convolvulus arvensis* (Family Convolvulaceae; Local name; Parwatay). Two tea spoonfull of decoction from leaves are taken on empty stomach to regulate the menstrual flow. The poultice from leaves serves as antiseptic.
15. *Cymbopogon jwarancusa* (Family Poaceae; Local name; Sargarey). Three gm crushed shoots are boiled in half liter of the water. The decoction thus obtained is given three times a day to treat typhoid fever. It is also believed that its smell is snake repellent.
16. *Equisetum arvense* (Family Equisetaceae; Local name; Bandukay). It is locally used to treat toothache. It is directly used as (meswak) thrice a day. Its decoction is also used for aching teeth.

17. *Euphorbia helioscopia* (Family Euphorbiaceae; local name; Parparay). Latex is poisonous and causes swelling. Mature leaves (5 gm) are mixed with 3 spoonful of sugar to prepare recipe which is taken twice a day to treat constipation. A high dose is poisonous.
18. *Fagonia indica* var. *schweinfurthii* (Family Zygophyllaceae; Local name; Spelagzay). It is used by the local hakims (herbalist) for curing abdominal pain and gastric troubles. Twigs and leaves crushed in water are drunk once a day to combat gastric trouble. It is also wormicidal.
19. *Ficus carica* (Family Moraceae; Local name; Inger). Six mature fruits are eaten twice a day to treat small pox. Few ripened fruits are crushed in a glass of curd to get a recipe which is called anger sharbat (syrup). It is given thrice a day to treat constipation. Unripe fruit when eaten cause sensation and burning of the tongue. To counteract it, leaves of the same plants are rubbed directly on the tongue.
20. *Malva parviflora* (Famly Malvaceae; Local name; Pachkay). Washed roots are dried and powdered. Two gm powder is mixed in butter is taken after dinner as sex tonic. It is also used as laxative.
21. *Malvastrum coromandelianum* (Family Malvaceae; Local name; Wada tikalai). Leave are chopped and boiled for half an hour. The filtrate is stored in container. One cup is drunk twice a day to heal inflammation and wounds.
22. *Medicago polymorpha* (Famly Papilionaceae; Local name; Shapethlary). Leaves and young shoots are crushed and fried as vegetable which is very useful for controlling blood pressure. It also serves as carminative.
23. *Melilotus alba* (Papilionaceae; Local name; Shinji). Powdered shoots (5 gm) are mixed with dahi (curd) as malaise. The inflorescence is used against foot athletes' disease by shepherds.
24. *Mentha longifolia* (Family Lamiaceae; Local name; Velanay). Equal amount of dried leaves and black tea are boiled in water. A cup of this herbal tea is taken three times a day for curing cold and fever. The dried powdered leaves and flowers, called as Nas kusha, are taken with or without some sugar three times a day to treat stomachache. Herbalist called velani tea (herbal tea) is prepared by boiling tea spoonful of leaves and flower with desired amount of sugar.

25. *Mentha spicata* (Family Lamiaceae; Local name; Podina). It is used as salad to relieve gastric trouble and as carminative.
26. *Ocimum basilicum* (Family Lamiaceae; Local name; Babary). The inflorescence is crushed and one teaspoonful extracts is taken thrice a day to treat cough, cold and common flu.
27. *Peganum harmala* (Family Zygophyllaceae; Local name; Spanda). About 40 gm crushed seeds are mixed with a cup of honey. A tea spoonful is taken once a day to treat fever, colic pain and for deworming tape worms. The powdered seeds mixed with mustard oil are rubbed on hairs once a day as antilice agent.
28. *Periploca aphylla* (Family Apocynaceae; Local name; Barara). Half cup fresh juice is taken twice a day to relieve constipation. The wood ash is used as poultice for curing swollen joints and other body parts.
29. *Plantago lanceolata* (Family Plantaginaceae; Local name; Lablaboo). Crushed leaves are chewed in mouth to relieve toothache. Seeds and fruits are drunk with water as purgative and laxative.
30. *Plantago major* (Family Plantaginaceae; Local name; Wada lablaboo). One tea spoonful of seeds are added to a glass of water with some sugar and taken twice a day for curing dysentery. The recipe is locally called *Spergula*. The powdered leaves and roots are swallowed with water twice a day to control fever.
31. *Ricinus communis* (Family Euphorbiaceae; Local name Randan). Seeds are eaten to induce vomiting.
32. *Rumex dentatus* (Family Polygonaceae; local name; Jungle sag). Use as vegetable is recommended once a week to combat cardiac problems.
33. *Salvadora oleoides* (Family Salvadoraceae; Local name; Pleman). Roots and branches are used for making miswak which is used for clearing teeth. Root bark is used as vesicant. It has been mentioned in the Holy Quran.
34. *Salsola foetida* (Family Chenopodiaceae; Local name; Spin lanray). Dried leaves and shoots are powdered and stored. It is used in making "kar" (local name of the recipe) which is used as hair wash as antilice agent.
35. *Solanum surattense* (Family Solanaceae; Local name; Wara maraghone). Seeds are smoked like cigarette to treat toothache. Crushed leaves are tied over the

broken organs to relieve pain. A tea spoonful of powdered drug is taken thrice a day with honey to treat cough. Boiled fruits mixed with sugar are used to prepare jam, which is used as health tonic and deworming agent.

36. *Suaeda fruticosa* (Family Chenopodiaceae; Local name; Tor lanry). Hundred gm dried powdered young shoots are taken daily for a week to eradicate head lice.
37. *Tamarix aphylla (*Family Tamaricaceae; Local name; Ghaz). Leaves and young branches, collected in the spring and early winter, are made into decoction and infusion. The decoction is taken orally and applied externally as lotion in relieving swelling and wounds.
38. *Tribulus terrestris* (Family Zygophyllaceae; Local name; Maklenda). Ten gm powder seeds mixed with 4 gm of maize flour is taken 3 times a day to expel kidney stone.
39. *Withania coagulans* (Family Solanceae; Local name; Khamazora). A tea spoonful of dried fruit powder is taken daily with a glass of water for curing stomach ache. Two or three seeds are chewed after lunch and dinner for treating gastric troubles.
40. *Withania somnifera* (Family Solanaceae; Local name; Kutilal). A paste, prepared by mixing powdered roots with oil, is spread on its leaves and used as bandages on swollen joints to treat rheumatism. Sometimes, the leaves are directly tied over the affected parts to relieve pain.
41. *Zizyphus mauritiana* (Family Rhamnaceae; Local name; Bera). The edible fruits are used as blood purifier. The decoction of fruits and barks is taken with a cup of milk to treat constipation and dysentery.

Table 48. Level of knowledge about medicinal plant by age and education group (%)

Age group	**No of plants known**			
	Up to 2	3- 4	+5	Total
Up to 20	3	-	-	3
21 – 40	10	7		17
41 – 60	5	5	40	50
61 – 80	-	2	28	30
Total	18	14	68	100
Education				
Illiterate	2	10	23	35
Primary	3	6	18	27
Middle	5	5	13	23
Matric	5	-	-	5
FA/ FSc	4	-	3	7
BA /BSc	-	2	-	2
MA/MSc	1	-	-	1
Total	20	23	57	100

Table 49. List of the important medicinal plant of District Tank.

No	**Botanical name**	**Local name**	**Family**
1.	*Acacia nilotica ssp.nilotica* (L.) Wild. ex Delile	Kikar	Mimosaceae
2.	*Achyranthes aspera* L.	Kutti boty	Amaranthaceae
3.	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schult.	Sperai	Amaranthaceae
4.	*Alhagi maurorum* Medic.	Thanda	Papilionaceae
5.	*Allium cepa* L.	Piaz	Alliaceae
6.	*Allium sativum* L.	Wozha	Alliaceae
7.	*Amaranthus viridis* L.	Ganar	Amarathaceae
8.	*Anagallis arvensis* L.	Gul boti	Primulaceae
9.	*Calotropis procera subsp. hamiltonii* (Wight) Ali	Spulmaka	Asclepiadaceae
10.	*Capparis decidua* (Forssk.) Edgew.	Kreta/ kirrha	Capparidaceae
11.	*Chenopodium album* L.	Sarmay	Chenopodiaceaea
12.	*Chenopodium murale* L.	Tora sarmay	Chenopodiaceae
13.	*Citrullus colocynthis* (L.) Schrad.	Ghata maraghone	Cucurbitaceae
14.	*Convolvulus arvesis* L.	Mal parwati	Convolvulaceae
15.	*Cymbopogon jwarancusa* (Jones) Schult.	Sargharay	Poaceae
16.	*Equisetum arvense* L.	Bandokay	Equisetaceae
17.	*Euphorbia helioscopia* L.	Parparay	Euphorbiaceae
18.	*Fagonia indica* var. *schweinfurthii* Hadidi	Spelaghzay/	Zygophyllaceae
19.	*Ficus carica* L.	Anger	Moraceae
20.	*Malva parviflora* L.	Pachkay	Malvaceae
21.	*Malvastrum coromandelianum* (L.) Garcke	Tikaley	Malvaceae

22.	*Medicago polymorpha* L.	Shpathlary	Amaranthaceae
23.	*Melilotus alba* Desr.	Shinji	Papilionaceae
24.	*Mentha longifolia* (L.) L.	Valanai	Lamiaceae
25.	*Mentha spicata* L.	Podina	Lamiaceae
26.	*Ocimum basilicum* L.	Babaray	Lamiaceae
27.	*Peganum harmala* L.	Spand/ spelanay	Zygophyllaceae
28.	*Periploca aphylla* Decne.	Barara	Apocyanaceae
29.	*Plantago lanceolata* L.	Chota lablabo	Plantaginaceae
30.	*Plantago major* L.	Ghat lablabo	Plantaginaceae
31.	*Ricinus communis* L.	Randun	Euphorbiaceae
32.	*Rumex dentatus* L.	Lablabo	Polygonaceae
33.	*Salsola foetida* Delile ex Spreng.	Lanrhay	Chenopodiaceae
34.	*Salvadora oleoides* Decne.	Plaman/plawan	Salvadoraceae
35.	*Solanum surattense* Burm. f.	Wara maraghune	Solanaceae
36.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	Toor lanrhay	Chenopodiaceae
37.	*Tamarix aphylla* (L.) Karst	Ghaz	Tamaricaceae
38.	*Tribulus terrestris* L.	Maklinday	Zygophyllaceae
39.	*Withania coagulans* (Stocks) Dunal	Khamazora	Solanaceae
40.	*Withania somnifera* (L.) Dunal	Kutilal	Solanaceae
41.	*Zizyphus mauritiana* Lam.	Bera	Rhamnaceae

Table 50. Listing position of medicinal plants by local respondents (%) in district Tank

S. No	Species	Total	Ranking order				
			1	2	3	4	5
1.	*Citrullus colocynthis* (L.) Schrad.	100	80	20	-	-	-
2.	*Fagonia indica* var. *schweinfurthii* Hadidi	80	60	20	-	-	-
3.	*Withania coagulans* (Stocks) Dunal	90	58	-	32	-	-
4.	*Periploca aphylla* Decne.	70	25	25		10	10
5.	*Peganum harmala* L.	65	-	33	20	-	12
6.	*Salvadora oleoides* Decne.	60	5	30	-	10	15
7.	*Solanum surattense* Burm. f.	50	15		30	5	
8.	*Calotropis procera subsp. hamiltonii* (Wight) Ali	45	-	40	-	-	5
9.	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	35			10	20	5-
10.	*Alhagi maurorum* Medic.	15	-	-	15	-	-
11.	*Malva parviflora* L.	5	-	-	-	5	-

Table 51. Criteria for considering the best medicinal plant by locals of District Tank.

Criteria	Name of species		
	Citrullus colocynthis (L.) Schrad.	*Withania coagulans* (Stocks) Dunal	*Fagonia indica* var. *schweinfurthii* Hadidi
Dyspepsia	-	5	55
Anthelminttic	-	-	30
Blood purifier	-	-	15
Digestive	-	55	-
Cooling agent	-	30	-
Constipation	50	10	-
Biliousness	30	-	-
Stomachache	20	-	-



a. b.

Fig. 4 (a – b). High degree of soil erosion in the range lands of District Tank.



a. b.

Fig. 5 (a - b). See the barren deserted look during summer when no forage is available for grazing livestock.



a . b.

Fig. 6. (a - b). *Tamarix aphylla* and *Zizyphus mauritiana* becoming bushy in response to heavy grazing in District Tank.



a. b.

Fig. 7. (a - b). Camel browsing of shrubs and trees have changed the physiognomy of vegetation by reducing species diversity and hampering regeneration. See the bare spaces between thickets.



a.



b.

Fig 8. (a – b). Sheep and Goat of local breed grazing on meager forage in the range land of District Tank. See the sparse vegetation which is being grazed to the ground level.



a. See the open low *Withania* vegetation



b. *Salvadora oliedes* carried as fuel wood



a. b.

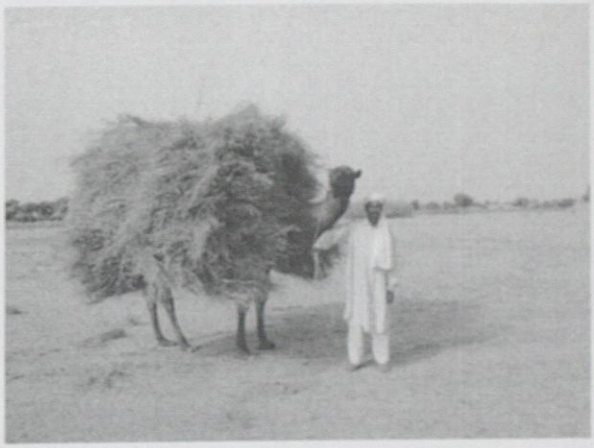
Fig 8. (a – b). Sheep and Goat of local breed grazing on meager forage in the range land of District Tank. See the sparse vegetation which is being grazed to the ground level.



a. See the open low *Withania* vegetation b. *Salvadora oliedes* carried as fuel wood



a. Dung cakes as fuel substitute



b. A camel load of fuel wood

Fig. 10. (a - b). Dung cakes the only substitute to fuel energy that further reduces the feedback tothe soil ecosystem. See the barn deserted range land.

CONSERVATION STATUS OF PLANTS

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Plant preservation means the study of plant declination, and their causes, and techniques to protect rare and scarce plants. Plant conservation or Conservation Biology is a fairly young field that emphasizes the conservation of biodiversity and whole ecosystems, as opposed to the conservation of individual species (Soule, 1985).

The present study dealt with 187 species growing wild in the research area that belonged to 53 families (Table 52). The data was collected for various conservation parameters following IUCN (2001). It was noted that 70 plant species (37.4%) were found vulnerable, 64 species (34.2%) endangered, 38 species (20.3%) rare and a small portion i.e. only 19 species (10.2%) were infrequent due to excessive collection, over grazing and other human influences in the investigated parts of District Tank (Fig. 11). None of the species was declared as dominant which highlighted the miserable current situation of plant resources in the area (Table 52). Some 34.2% species are endangered. Plants such as *Acacia modesta, Capparis decidua, Zizyphus, Rhazya stricta* and *Periploca calophylla* have become endangered due to their slow growth, regeneration and multiple uses. These plants are grazed heavily, used for medicinal purposes, used as fuel wood and at the same times used as timber wood. Coupled with harsh climatic and habitat condition which has slow down their natural regeneration. These plants have become endangered. Plants like *Saccharum bengalense* and *Saccharum munja* etc are intensively used for thatching and as basketry materials. These two have low regeneration in patches. Aridity of area and extensive clipping has pushed them into endangered categories. Other categories include fuel wood species such as *Phoenix dactylifera, Capparis decidua* and *Acacia modesta*. Annual like *Cynoglossum lanceolatum* and *Malcolmia scorpioides* and perennials include *Imperata cylindrical, Echinochloa colona, Saccharum bengalense* and *Vicia faba* have become endangered or vulnerable owing to grazing. In this dry arid environment, there is always deficiency of forage and livestock graze every green soft textured plant resulting in their reduction and hampered regeneration. Some plants like *Viola* etc which prefer shady moist habitat are medicinal. Over collection as medicinal material and lack of suitable habitat has hampered their regeneration leading them to endanger or vulnerable category. All these major utilities have hampered their regeneration to push them into endangered categories. These plants

are being used for various purposes like fuel wood, timber wood, fodder/forage and as health care medicines. Hamayun *et al*. (2006) also reported that most of the local flora is threatened due to over collection and deforestation. *Viola stocksii*, *Pulicaria crispa*, *Ifloga spicata*, *Hypecoum pendulum*, *Crotolaria burhia* and *Astragalus amherstianus* etc were seriously threatened among the herbaceous species in this area while, *Ficus carica*, *Calligonum polygonoides*, *Salvadora oleoides*, and *Capparis decidua* were among the shrubs. *Phoenix dactylifera* and *Acacia modesta* may become endangered if not conserved. Hamilton (2004) and Heywood & Iriondo (2003) stated that *ex-situ* conservation should be encouraged for conservation of medicinal plant and livelihood. In the present case, too, as the area is under tremendous anthropogenic pressure therefore *ex-situ* conservation of endangered species along with the habitat is recommended. The woody plants cut down for miscellaneous purposes, are facing conservational problems. Sayer *et al*. (2004) reported that large investments are being made in the establishment of tree plantation on degraded area in Asia. However, in the present case no project or programs for conservation of forest or vegetation is operating. Twenty one flowering plants are reported to be threatened in Pakistan (Ali & Qaiser, 2010). They reported *Silene longisepala* and *Astragalus gahiratensis* which is more or less similar to our case where *Silene conoidea* and *Astragalus amherstianus* respectively ranked as vulnerable and endangered species. Alam & Ali (2009, 2010) stressed that proper conservation studies are almost negligible in Pakistan. Haq (2011) reported 37 taxa which were either critically endangered or endangered and some of the plants species like *Withania somnifera* and *Viola* sp. were same in both the cases. This also supported the present work as more than half of the investigated plants were either endangered or vulnerable (Table 52).

The 38 rare species in the present studies are extensively utilized for medicinal purposes, which need special attention for conservation. These include *Withania coagulans*, *Salvadora oleoides*, *Centaurium spicatum* and *Solanum surattense*. Haq (2011) concluded that rare species is not only significant at national or local level but also for the global biodiversity. Therefore, the present study suggests that on time remedial measure for conservation of the flora must be taken. The present study concludes that over population and the transhumance of internally displaced persons (IDPs) from Waziristan

have created unsound situation. The mass movement of population from their area into Tank District has put tremendous pressure on plant resources. These IDPs moved from their native places along with their belongings and livestock facing miseries of all kinds such as lack of food, shelter and fodder etc. They definitely overwhelmingly used the available plant resources for making shelter, fuel wood, fodder and some used them for earning livelihood. This changed the ecology of the area. Similarly, Kim (2006) reported that plant resources of Korea are threatened due to the high population density and speedy industrialization since the early sixties, in combination with the unlawful gathering of wild plants for decorative, remedial, food purposes, fuel and timber and fodder purposes. This is what has happened in the investigated area. The infrequent species like *Juncus bufonius*, *Juncus inflexus*, *Cyprus rotundus*, *Desmostachya bipinnata* and *Typha latifolia* (Table 52) were secure probably due to its non palatable nature due to morphological adaptation. Ahmad *et al*. (2007) observed that most of the plants in mountainous region of Pakistan survived due to some morphological, anatomical and physiological adaptation to the environment. Other worker like Abbas *et al*. (2010) considered *Cadaba heterotricha* as endangered species in Pakistan while, Hadi *et al*. (2009) working on the vegetation of graveyard in Peshawar stated that *Aerva javanica*, *Capparis decidua*, *Prosopis farcta* and *Peganum harmala* was common in graveyard but absent in the surrounding areas due to overexploitation.

Table 52. Ranking of species using IUCN criteria for conservation status of plants of District Tank.

No.	Divivision / Family / Species	Availability class	Collection status	Part used	Growth behavior	Total score	Conservation status
A.	**PTERIDOPHYTA**						
1	**Equisetaceae**						
1	*Equisetum arvense* L.	0	3	0	3	6	Vulnerable
B.	**MONOCOTYLEDONS**						
2	**Arecaceae**						
2	*Phoenix dactylifera* L.	1	1	0	0	2	Endangered
3	**Asphodelaceae**						
3	*Asphodelus tenuifolius* Cav.	3	3	0	3	9	Rare
4	**Cypraceae**						
4	*Cyprus difformis* L.	2	3	4	4	13	Infrequent
5	*Cyprus rotundus* L.	2	3	4	4	13	Infrequent
5	**Juncaceae**						
6	*Juncus bufonius* L.	2	3	4	4	13	Infrequent
7	*Juncus inflexus* L.	1	3	4	4	12	Rare
6	**Poaceae**						
8	*Aristida adscensionis* L.	2	2	0	4	8	Vulnerable
9	*Aristida cyanantha* Nees ex Steud.	2	2	0	4	8	Vulnerable
10	*Aristida mutabilis* Trin. & Rupr.	1	3	3	0	7	Vulnerable
11	*Aristida triticoides* Henr.	1	3	3	0	7	Vulnerable
12	*Avena sativa* L.	3	3	0	4	10	Rare
13	*Cenchrus biflorus* Roxb.	1	3	4	3	11	Rare
14	*Cenchrus ciliaris* L.	1	3	4	3	11	Rare

15	*Cymbopogon jwarancusa* (Jones) Schult.	2	2	0	3	7	Vulnerable
16	*Cynodon dactylon* (L.) Pers.	3	1	0	4	8	Vulnerable
17	*Dactyloctenium aegyptium* (L.) Willd.	0	2	0	2	4	Endangered
18	*Desmostachya bipinnata* (L.) Stapf.	3	3	4	4	14	Infrequent
19	*Dichanthium annulatum* (Forssk.) Stapf.	3	3	4	4	14	Infrequent
20	*Echinochloa colona* (L.) Link.	0	2	0	2	4	Endangered
21	*Echinochloa crus-galli* (L.) Beauv.	0	2	0	2	4	Endangered
22	*Eragrostis cilianensis* (All.) Lut. ex F.T.	3	1	0	4	8	Vulnerable
23	*Eragrostis minor* Host	3	1	0	4	8	Vulnerable
24	*Imperata cylindrica* L.	0	2	0	2	4	Endangered
25	*Ochthochloa compressa* (Forssk.) Hilu	0	2	0	2	4	Endangered
26	*Panicum antidotale* Retz.	3	1	0	4	8	Vulnerable
27	*Panicum capillare* L.	3	1	0	4	8	Vulnerable
28	*Phalaris aquatica* L.	3	1	0	4	8	Vulnerable
29	*Phragmites karka* (Retz.) Trin. ex Steud.	1	2	1	1	5	Vulnerable
30	*Poa annua* L.	1	2	0	3	8	Vulnerable
31	*Poa infirma* H. B. K.	1	2	0	3	8	Vulnerable
32	*Polypogon monspeliensis* (L.) Desf.	0	2	0	2	4	Endangered
33	*Saccharum bengalense* Retz.	0	2	0	2	4	Endangered

34	*Saccharum munja* Roxb.	0	2	0	2	4	Endangered
35	*Saccharum spontaneum* L.	0	2	0	2	4	Endangered
36	*Schismus barbatus* (L.) Thell.	1	3	4	3	11	Rare
37	*Sclerochloa dura* (L.) P. Beauv.	1	2	1	1	5	Vulnerable
38	*Setaria verticillata* (L.) P. Beauv.	1	2	1	1	5	Vulnerable
7	**Typhaceae**						
39	*Typha latifolia* L.	3	2	4	4	13	Infrequent
40	*Typha minima* Funck ex Hoppe	1	3	4	3	11	Rare
C.	**DICOTYLEDON**						
1	**Aizoaceae**						
41	*Trianthema portulacastrum* L.	0	2	0	2	4	Endangered
2	**Amaranthaceae**						
42	*Aerva javanica* (Burm. f.) Juss.	1	3	4	3	11	Rare
43	*Achyranthes aspera* L.	1	2	1	1	5	Vulnerable
44	*Aerva lanata* (L.) Juss. ex Schult.	1	2	1	1	5	Vulnerable
45	*Amaranthus graecizans* L.	1	3	4	3	11	Rare
46	*Amaranthus spinosus* L.	1	3	4	3	11	Rare
47	*Amaranthus viridis* L.	1	2	1	1	5	Vulnerable
3	**Apiaceae**						
48	*Anethum graveolens* L.	1	2	1	1	5	Vulnerable
49	*Psammogeton biternatum* Edgew.	1	3	4	4	12	Rare
50	*Torilis japonica* (Houtt.) DC.	0	2	0	2	4	Endangered
4	**Apocyanaceae**						
51	*Rhazya stricta* Decne.	0	2	0	2	4	Endangered
5	**Asclepiadaceae**						
52	*Calotropis procera subsp.*	2	3	4	3	12	Rare

	hamiltonii (Wight) Ali						
53	*Oxystelma esculentum* (L. f.) R. Brown	0	2	0	2	4	Endangered
54	*Periploca aphylla* Decne.	1	2	1	1	5	Vulnerable
55	*Periploca calophylla* (Wight) Falc.	0	2	0	2	4	Endangered
6	**Asteraceae**						
56	*Centaurea iberica* Trevir. ex Spreng.	0	2	0	2	4	Endangered
57	*Centurea moscuata* L	0	2	0	2	4	Endangered
58	*Conyza canadensis* (L.) Cronquist	1	3	4	4	12	Rare
59	*Cousinia minuta* Boiss.	3	3	4	4	14	Infrequent
60	*Eclipta alba* (L.) Hassk.	1	2	1	1	5	Vulnerable
61	*Filago arenaria* (Smoljan.) Chrtek & Holub	0	2	0	2	4	Endangered
62	*Ifloga spicata* (Forssk.) Sch. Bip.	0	1	0	1	2	Endangered
63	*Launaea nudicaulis* (L.) Hook.f.	1	1	4	1	7	Vulnerable
64	*Pulicaria crispa* (Forssk.) B.H.	0	1	0	1	2	Endangered
65	*Sonchus asper* (L.) Hill	2	2	4	4	10	Rare
66	*Sonchus oleraceus* L.	0	1	0	1	2	Endangered
67	*Taraxacum officinale* F. H. Wigg.	2	2	4	4	10	Rare
68	*Tricholepis chaetolepis* (Boiss.) Rech. f.	1	2	1	1	5	Vulnerable
69	*Xanthium strumarium* L.	1	1	3	0	5	Vulnerable
7	**Boraginaceae**						
70	*Arnebia hispidissima* (Lehm.) A. DC.	1	3	0	4	8	Vulnerable
71	*Arnebia guttata* Bunge	1	3	0	4	8	Vulnerable

72	*Cynoglossum lanceolatum* Forssk.	0	1	0	1	2	Endangered
73	*Gastrocotyle hispida* (Forssk.) Bunge	0	1	0	1	2	Endangered
74	*Heliotropium elipticum* Ledeb.	0	3	4	0	7	Vulnerable
75	*Heliotropium europaeum* L.	0	3	4	0	7	Vulnerable
76	*Heliotropium ovalifolium* Forssk.	0	3	4	0	7	Vulnerable
8	**Brassicaceae**						
77	*Coronopus didymus* (L.) Smith	0	1	0	1	2	Endangered
78	*Crambe cordifolia* Steven	0	1	0	1	2	Endangered
79	*Farsetia hamiltonii* Royle	0	1	0	1	2	Endangered
80	*Farsetia ramosissima* Hochst. ex Boiss.	0	1	0	1	2	Endangered
81	*Malcolmia africana* (L.) R. Br.	0	1	0	1	2	Endangered
82	*Malcolmia scorpioides* (Bunge) Boiss.	0	1	0	1	2	Endangered
83	*Matthiola incana* (L.) R. Br.	2	3	4	4	13	Infrequent
84	*Sisymbrium irio* L.	2	3	4	4	13	Infrequent
9	**Campanulaceae**						
85	*Campanula benthamii* Wall. ex Kitamura	0	2	0	4	6	Vulnerable
86	*Campanula sulaimanii* E. Nasir.	0	1	0	1	2	Endangered
10	**Capparidaceae**						
87	*Capparis decidua* (Forssk.) Edgew.	0	1	0	1	2	Endangered
88	*Cleome brachycarpa* Vahl ex DC.	0	1	0	1	2	Endangered
11	**Caryophyllaceae**						
89	*Silene conoidea* L.	0	2	0	4	6	Vulnerable

90	*Spergula arvensis* L.	0	2	0	4	6	Vulnerable
91	*Spergularia marina* (L.) Griseb.	1	3	2	3	9	Rare
12	**Ceasalpinaceae**						
92	*Cassia senna* L.	0	3	1	0	4	Endangered
13	**Chenopodiaceae**						
93	*Atriplex griffithii* Moq.	1	3	2	3	9	Rare
94	*Chenopodium album* L.	2	3	4	4	13	Infrequent
95	*Chenopodium ambrosioides* L.	2	3	4	4	13	Infrequent
96	*Chenopodium murale* L.	2	3	4	4	13	Infrequent
97	*Chenopodium nepalense* Colla	1	3	2	3	9	Rare
98	*Halostachys belangerana* (Moq.) Botsch.	0	3	1	0	4	Endangered
99	*Haloxylon multiflorum* (Moq.) Bunge.ex Boiss.	1	3	2	3	9	Rare
100	*Kochia indica* Wight	0	2	0	4	6	Vulnerable
101	*Salsola foetida* Del.ex Spreng.	3	3	4	4	14	Infrequent
102	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	3	3	4	4	14	Infrequent
14	**Convolvulaceae**						
103	*Convolvulus arvensis* L.	3	3	4	4	14	Infrequent
104	*Convolvulus microphyllus* Sieb.ex Spreng.	1	3	2	3	9	Rare
105	*Convolvulus prostrata* Forssk.	1	3	2	3	9	Rare
15	**Cucurbitaceae**						
106	*Citrullus colocynthis* (L.) Schrad.	1	2	2	3	8	Vulnerable
16	**Cuscutaceae**						
107	*Cuscuta reflexa* Roxb.	1	0	0	0	1	Endangered

17	**Euphorbiaceae**						
108	*Chrozophora oblongifolia* (Delile) Adr. Juss. ex Spreng.	1	3	0	3	7	Vulnerable
109	*Chrozophora tinctoria* (L.) Raf.	1	3	0	3	7	Vulnerable
110	*Euphorbia dracunculoides* Lam.	1	3	0	3	7	Vulnerable
111	*Euphorbia granulata* Forssk.	0	2	0	3	5	Vulnerable
112	*Euphorbia helioscopia* L.	3	3	4	4	14	Infrequent
113	*Euphorbia prostrata* Ait.	0	2	0	3	5	Vulnerable
114	*Euphorbia thymifolia* L.	0	2	0	3	5	Vulnerable
18	**Fumariaceae**						
115	*Fumaria indica* (Hausskn.) Pugsley	1	0	0	0	1	Endangered
19	**Gentianaceae**						
116	*Centaurium spicatum* (L.) Fritsch	0	3	3	3	9	Rare
117	*Centaurium pulchellum* (Sw.) Druce	1	0	3	1	5	Vulnerable
20	**Hypericaceae**						
118	*Hypericum perforatum* L.	1	0	0	0	1	Endangered
21	**Lamiaceae**						
119	*Mentha longifolia* (L.) L.	1	0	0	4	5	Vulnerable
120	*Mentha spicata* L.	1	0	0	4	5	Vulnerable
22	**Malvaceae**						
121	*Abutilon bidentatum* Hochst.ex A. Rich.	0	0	3	1	4	Endangered
122	*Malva neglecta* Wallr.	0	0	4	4	8	Vulnerable
123	*Malva parviflora* L.	0	0	4	4	8	Vulnerable
124	*Malvastrum coromandelianum* (L.) Garcke	0	0	4	4	8	Vulnerable

23	**Mimosaceae**						
125	*Acacia modesta* Wall.	0	0	4	0	4	Endangered
126	*Acacia nilotica ssp. nilotica* (L.) Wild. ex Delile	3	0	4	4	11	Rare
127	*Prosopis cineraria* (L.) Druce	3	3	4	4	14	Infrequent
128	*Prosopis farcta* (Banks & Sol.) Macbride	2	0	4	3	9	Rare
129	*Prosopis juliflora* Swartz	0	3	2	1	6	Vulnerable
24	**Moraceae**						
130	*Ficus carica* L.	0	0	2	0	2	Endangered
25	**Nyctiginaceae**						
131	*Boerhavia diffusa* L.	0	3	4	3	10	Rare
132	*Boerhavia procumbens* Banks ex Roxb.	0	3	4	3	10	Rare
26	**Oxalidaceae**						
133	*Oxalis corniculata* L.	0	3	2	1	6	Vulnerable
27	**Papavaraceae**						
134	*Hypecoum pendulum* L.	0	0	2	0	2	Endangered
28	**Papilionaceae**						
135	*Alhagi maurorum* Medic.	3	3	4	0	10	Rare
136	*Astragalus tribuloides* Delile	3	3	4	0	10	Rare
137	*Astragalus amherstianus* Royle ex Benth.	0	0	2	0	2	Endangered
138	*Crotolaria burhia* Buch.-Ham. ex Benth.	0	0	2	0	2	Endangered
139	*Cyamopsis tetragonoloba* (L.) Taubert	0	0	2	0	2	Endangered
140	*Lathyrus aphaca* L.	0	2	4	4	10	Rare

141	*Lathyrus sativus* L.	0	2	4	4	10	Rare
142	*Medicago minima* (L.) Grufb	1	1	3	0	5	Vulnerable
143	*Medicago polymorpha* L.	1	1	3	0	5	Vulnerable
144	*Medicago laciniata* (L.) Mill.	1	1	3	0	5	Vulnerable
145	*Melilotus indica* (L.) All.	0	1	3	4	8	Vulnerable
146	*Melilotus alba* Desr.	0	1	3	3	7	Vulnerable
147	*Vicia faba* L.	0	0	2	0	2	Endangered
148	*Vicia tetrasperma* (L.) Schreber	0	0	2	0	2	Endangered
29	**Portulacaceae**						
149	*Portulaca quadrifida* L.	0	3	0	2	5	Vulnerable
30	**Plantaginaceae**						
150	*Plantago ciliata subsp. lanata* (Boiss.) Rech.	0	0	2	0	2	Endangered
151	*Plantago lanceolata* L.	0	0	2	0	2	Endangered
152	*Plantago major* L.	1	0	2	0	3	Endangered
31	**Polygonaceae**						
153	*Calligonum polygonoides* L.	1	0	2	0	3	Endangered
154	*Emex australis* Steinh.	2	2	4	4	12	Rare
155	*Emex spinosus* (L.) Campd.	1	0	2	0	3	Endangered
156	*Polygonum patulum* M. Bieb.	1	2	2	0	5	Vulnerable
157	*Polygonum plebejum* R. Br.	1	2	2	0	5	Vulnerable
158	*Rumex dentatus* L.	2	3	4	4	13	Infrequent
159	*Rumex obtusifolius* L.	1	0	2	0	3	Endangered
32	**Primulaceae**						
160	*Anagallis arvensis* L.	1	0	2	0	2	Endangered

33	**Ranunculaceae**						
161	*Ranunculus muricatus* L.	0	3	3	3	9	Rare
162	*Ranunculus sceleratus* L.	0	3	3	3	9	Rare
34	**Resedaceae**						
163	*Oligomeris linifolia* (Vahl) Macbride	1	0	2	0	2	Endangered
164	*Reseda odorata* L.	1	0	2	0	2	Endangered
35	**Rhamnaceae**						
165	*Zizyphus mauritiana* Lam.	2	1	2	2	7	Vulnerable
166	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	0	1	2	1	4	Endangered
36	**Salvadoraceae**						
167	*Salvadora oleoides* Decne.	0	0	0	0	0	Endangered
37	**Sapindaceae**						
168	*Dodonaea viscosa* (L.) Jacq.	0	1	2	1	4	Endangered
38	**Scrophulariaceae**						
169	*Veronica aquitica* Bern.	0	1	2	1	4	Endangered
170	*Veronica biloba* L.	0	3	2	4	9	Rare
39	**Solanaceae**						
171	*Datura alba* Nees	0	1	2	1	4	Endangered
172	*Hyoscyamus squarrosus* Griff.	0	1	2	1	4	Endangered
173	*Solanum nigrum* L.	0	1	2	1	4	Endangered
174	*Solanum surattense* Burm. f.	2	3	2	3	10	Rare
175	*Withania coagulans* (Stocks) Dunal	2	3	2	3	10	Rare
176	*Withania somnifera* (L.) Dunal	1	3	2	1	7	Vulnerable

40	**Tamaricaceae**						
177	*Tamarix aphylla* (L.) Karst	3	2	0	3	8	Vulnerable
178	*Tamarix dioica* Roxb. ex Roth.	3	2	0	3	8	Vulnerable
41	**Tiliaceae**						
179	*Corchorus aestuans* L.	0	0	2	3	5	Vulnerable
42	**Ulmaceae**						
180	*Celtis eriocarpa* Decne.	0	0	2	3	5	Vulnerable
43	**Urticaceae**						
181	*Urtica pilulifera* L.	1	0	4	3	8	Vulnerable
44	**Verbinaceae**						
182	*Vitex negundo* L.	1	0	4	3	8	Vulnerable
45	**Violaceae**						
183	*Viola stocksii* Boiss.	0	0	0	0	0	Endangered
46	**Zygophyllaceae**						
184	*Fagonia indica* var. *schweinfurthii* Hadidi	2	1	0	3	6	Vulnerable
185	*Peganum harmala* L.	1	0	4	3	8	Vulnerable
186	*Tribulus terrestris* L.	1	0	4	3	8	Vulnerable
187	*Tribulus pentandrus* Forssk.	0	1	3	0	4	Endangered

Key:

1. Availability

0 = Uncommon or very rare
1 = Less common or rare
2 = Occasional
3 = Abundant

2. Collection

0 = More than 1000 kg/yr
1 = Consumed from 500-1000 kg/yr
2 = Consumed from 300-500 kg/yr
3 = Consumed from 100-200 kg/yr

3. Growth

0 = Regrowth in more 3 years
1 = Regrowth within 3 years
2 = Regrowth within 2 years
3 = Regrowth within 1 year
4 = Regrowth in a season

4. Part used

0 = Root/Whole plant
1 = Bark
2 = Seeds, Fruits
3 = Flowers
4 = Leaves/Gum/Latex

5. Total Score:

1. 0 - 4 Endangered:
2. 5 - 8 Vulnerable:
3. 9 - 12 Rare:
4. 13 - 14 Infrequent:
5. 15 - 16 Dominant.

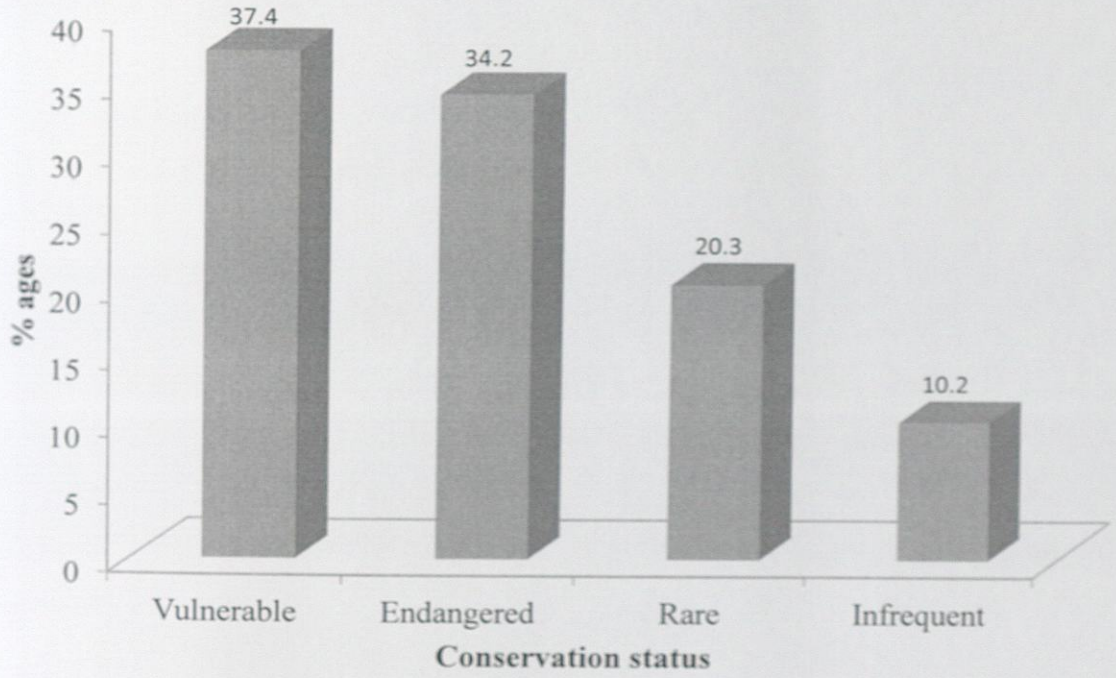


Fig. 11. Conservation status of flora of District Tank.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

General Conclusions

1. This study was conducted during 2007-2010 to illuminate the floristic, vegetation structure, productivity, range lands condition, chemical compositions and people plant interaction.
2. The study revealed that flora of District Tank comprised of 205 species that belonged to 56 families. Of them 159 species belonged to Dicot, 45 species to Monocot and single representative of pteridophyte.
3. Based on number of species, Poaceae, Papilionaceae, Asteraceae, Chenopodiaceae and Brassicaceae were the most prevalent families. Quantitatively, based on FIV the situation was drastically changed. Mimosaceae, Chenopodiaceae, Poaceae and Asclepiadaceae were important families.
4. The flora was dominated by therophytic, hemicryptophytic, geophytic, chamaephytic, nanophyllous, leptophyllous, microphyllous and mesophyllous species. This is well in accordance with the climate of the area.
5. As a whole the month of March had the peak flowering season. The flowering was related to the nature of rainfall. The month of April was the peak fruiting season; while October - November were the dormant months.
6. Ethnobotanical study indicated that the plants are primarily used as fodder (69.3%), followed by medicinal (22.4 %), fuel wood (17.6%), roof thatching (5.8 %), timber (5.4%), vegetables (4.4 %), edible fruits (3.4 %), condiment (2.4 %) and furniture (1.5 %). This indicated the major utility of the area as rangeland.
7. There is a severe shortage of timber and fuel wood that has promoted deforestation.
8. The total average biomass productivity during spring was high. It was followed by autumn. There was a decline in production during winter and summer season.
9. Palatability study indicated that there were 149 palatable species with varying degrees of palatability. The ratio of palatable to total species was 1: 1.3 and non palatable to the total was 1: 3.7. They included 33 species which were highly palatable, 33 species mostly palatable, 42 species less palatable and 43 species were rarely palatable. This indicated non availability of sufficient forage species in the area.

10. Palatability of plants depends upon nutritional need and energy of animals. Among the palatable species, 72 species were grazed by sheep. They included 42 herbs, 22 grasses, 3 shrubs and 5 trees. Goats preferred 66 species which included 27 herbs, 16 grasses, 14 shrubs and 9 trees. Similarly camel and cow respectively preferred 40 and 36 species.
11. Phytosociological study and Ordination approach showed 24 plant communities and 4 main associations; wood land halophytes association, xero-sere herbaceous association, thorny woody association and degraded woody associations in the area.
12. The physico-chemical analysis of habitat features revealed that the soil texture was mostly sandy and sandy-clay with pH ranging from 7.8 - 8.6. Flora, vegetation structure and its productivity was governed by soil texture and structure and its chemical composition.
13. Chemical analysis of forage plants suggested that with few exceptions sufficient levels of macro- and micro-minerals and nutrients were present in the investigated forage plants. Therefore, there is no need to supplement minerals and nutrients in feed to the ruminants. However, these fodders species are under stress and need sustainable utilization for the longevity of the rangelands.
14. Based on IUCN conservation criteria, it was noted that 70 plant species (37.4%) were vulnerable, 64 species (34.2%) endangered, 38 species (20.3%) rare and a small portion i.e. only 19 species (10.2%) were infrequent. This is due to excessive collection, over grazing and other human influences in the investigated parts of District Tank. None of the species was declared as dominant which highlighted the miserable current situation of plant resources in the area.

Recommendations and Suggestions

1. Moderate and rotational grazing management be enforced to enhance the regeneration of primary producers i.e. vegetation.
2. There is severe deforestation pressure on woody and shrubby species especially on *Acacia nilotica* ssp. *nilotica* and *Tamarix aphylla* for large quantity of wood extraction for fuel and timber. Therefore, alternate source of fuel/timber be provided and the area must be protected for a period of at least 10 years to promote vegetation cover.
3. Retrogression and disclimax of climax community is frequent. It can be managed by regulating sustainable grazing and deforestation with the participation of influential of the area.
4. There is an imperative need to promote principles that conservation and development of natural vegetation is indispensable for soil and land management. Because soil is being eroded very fast due to low vegetation cover.
5. There should be more avenues such as exploration of research activity for knowing the germination, seed production and growth pattern for successful propagation and reintroduction of fodder, timber, fuel wood and medicinal plant.
6. Cooperation and participation of local people is essential to impose effective management plan which might be possible with the help of the prominents of the area.
7. No marketing policies were pragmatic in the investigated area therefore marketing for livestock and medicinal plants should be initiated and regulated.
8. Equilibrium between food and feed supply, nutrient input, hybrid livestock population and human influences will be critical for long life sustainability of rangeland.
9. Strong linkages among international, regional and sub-regional research and developmental programs are required to appliance an integrated management plans so that ecological and socioeconomic conditions could be addressed appropriately.

10. Ecotourism could be eager in the area as base camp to South Waziristan Agency. This will be an additional source of income to uplift the socioeconomic situation of the area.
11. To improve and ensure the overall sustainable biological productivity from this area, long term plans are needed which might include rehabilitation of degraded habitats by introducing fast growing fodder species, replacement of low yielding livestock with improved breeds, rotational and mixing grazing. Such long terms efforts might reduce pressure and allow the flora and fauna to revert to its original position.

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APPENDICES

Appendix 1. Phytosociological attributes of *Typha-Tamarix aphylla-Tamarix dioica* community at water logged area during autumn 2008

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf Size	Life Form
A. Trees layers										
1	*Phoenix dactylifera* L.	10	8.5	80	7.6	9.1	10.1	26.8	Mes	Mp
2	*Tamarix aphylla* (L.) Karst	15	14.9	100	11	15.9	12.7	40.0.b	L	Mp
3	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	3.8	40	2.8	4	5.1	14.7	L	Mp
B. Shrubs layers										
4	*Tamarix dioica* Roxb ex. Roth.	9	16.9	70	6.9	18	8.9	33.8.c	L	NP
5	*Prosopis cineraria* (L.) Druce	4	9.4	50	3	10	6.3	19.3	L	NP
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	3	2.5	30	2.3	2.6	3.8	8.7	L	Ch
7	*Salsola foetida* Del.ex Spreng.	1	0.3	10	0.8	0.3	1.3	2.4	L	Ch
8	*Vitex negundo* L.	1	0.3	10	0.8	0.3	1.3	2.4	N	Np
C. Herbs layers										
9	*Typha latifolia* L.	34	13	100	26	13.9	12.7	52.5.a	Mes	G
10	*Cyprus defformis* L.	7	1.2	46.7	5.3	1.3	5.9	11.5	N	G
11	*Aristida mutabilis* Trin & Rupr.	4	0.7	26.7	3	0.7	3.4	7.1	N	Th
12	*Achyranthes aspera* L.	2	0.3	13.3	1.5	0.3	1.7	3.5	N	Th
13	*Polygonum patulum* M. Bieb.	2	0.3	13.3	1.5	0.3	1.7	3.5	N	G
14	*Phragmites karka* (Retz.) Trin. ex Steud.	16	10.5	73.3	12	11.2	9.3	32.5	Mes	Ch
15	*Cyprus rotundus* L.	4	0.7	26.7	3.1	0.7	3.3	7.1	N	G
16	*Imperata cylindrica* L.	7	5.4	46.6	5.3	3.6	5.9	14.9	L	G
17	*Euphorbia thymefolia* L.	4	0.7	26.7	3	0.7	3.4	7.1	L	Th

Appendix 2. Phytosociological attributies of *Desmostachya-Chenopodium-Acacia* community near cultivated lands during autumn 2008.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Lif form
A. Trees layrs										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	8	11.6	80	8.8	22.2	13.6	44.6	L	Mp
2	*Zizyphus mauritiana* Lam.	2	2.3	40	2.2	4.4	6.8	13.4	N	Mp
3	*Tamarix aphylla* (L.) Karst	4	4	60	4.4	7.6	11.2	22.2	L	Mp
4	*Prosopis farcta* (Banks & Sol.) Macbride.	2	3.4	40	2.2	6.5	6.8	15.5	L	Mp
B. Shrubs layers										
5	*Zizyphus nummularia* Burm. (f.) Wight & Arn.	4	2.5	30	4.4	4.8	5.1	14.3	N	Np
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	2	2.2	20	2.2	4.2	3.4	9.8	L	Ch
7	*Salsola foetida* Del.ex Spreng.	2	0.6	20	2.2	1.1	3.4	6.7	L	Ch
8	*Atriplex griffithii* Moq.	3	1	30	3.3	2	5.1	10.4	N	Np
C. Herbs layers										
9	*Chenopodium murale* L.	24	11.8	86.7	26.4	22.6	14..8	63.8	L	Th
10	*Desmostachya bipinnata* (L.) Stapf.	27	10	100	29.7	19	16.9	65.7	N	H
11	*Convolvulus microphyllus* Sieb.ex Spreng.	6	1.7	33.3	6.6	3.2	5.7	15.6	N	Th
12	*Amaranthus viridis* L.	4	0.7	26.7	4.4	1.3	4.5	10.2	N	Th
13	*Boerhavia procumbens* Banks ex Roxb.	3	5	20	3.5	1	3.4	7.9	N	H
Total		91	52.3	586.7	99.9	99.9	99.8	299.7		

Appendix 3. Phytosociological attributies of *Saccharum-Citrullus-Tribulus* community at sandy area during autumn 2008.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Prosopis farcta* (Banks & Sol.) Macbride.	8	4.7	80	6.8	5	9.7	21.5	L	Mp
2	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	2.9	60	2.5	3.1	7.2	12.8	L	Mp
B. Shrubs layers										
3	*Salvadora oleoides* Decne.	5	7.8	50	4.2	8.3	6	18.5	N	Np
4	*Periploca calophylla* (Wight) Falc.	3	5.6	30	2.5	5.9	3.6	12	Ap	Np
5	*Capparis decidua* (Forssk.) Edgew.	6	9.4	60	5.1	10	7.2	22.3	Ap	Np
6	*Prosopis cineraria* (L.) Druce	4	5.9	40	3.4	6.3	4.8	14.5	L	Np
7	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	6	1.7	60	5.1	1.8	7.2	14.1	Mes	Ch
C. Herbs layers										
8	*Saccharum munja* Roxb.	20	20.8	80	16.9	22.1	9.7	48.7.a	N	Ch
9	*Tribulus terristris* L.	15	11.2	93.3	12.7	11.9	11.3	35.9.c	L	H
10	*Citrullus colocynthis* (L.) Schrad.	20	17.7	93.3	17	18.8	11.3	47.1.b	Mic	Th
11	*Cynoglossum lanceolatum* Forssk.	5	0.8	33.3	4.2	0.8	4	9	N	H
12	*Cenchrus biflorus* Roxb.	4	0.7	26.7	3.4	0.7	3.2	7.3	L	H
13	*Aristida adscensionis* L.	6	1	40	5.1	1.1	4.8	11	Mic	H
14	*Convolvulus prostratus* Forssk.	6	1.7	33.3	5.1	1.8	4	10.9	L	Th
15	*Plantago ciliata* subsp. *lanata* (Boiss.) Rech.	3	1.3	20	2.5	1.4	2.4	6.3	N	Th
16	*Cynodon dactylon* (L.) Pers.	4	0.7	26.7	3.4	0.7	3.2	7.3	L	H
Total		118	93.9	826.6	99.9	99.7	99.6	299.2		

Appendix 4. Phytosociological attributes of *Salvadora-Periploca-Withania* community at foothills during autumn 2008.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia modesta* Wall.	4	2.5	60	4.5	2.2	8.7	15.4	L	Mp
2	*Acacia* nilotica ssp. *nilotica* (L.) Delile	3	2.9	60	3.4	2.5	8.7	14.6	L	MP
B. Shrubs layers										
3	*Salvadora oleoides* Decne.	16	33.7	90	18	29.4	13	60.4.a	N	Np
4	*Periploca aphylla* Decne.	12	17.8	80	14	15.5	11.6	40.6.b	Ap	Np
5	*Periploca calophylla* (Wight) Falc.	4	2.8	40	4.5	2.4	5.8	12.7	Ap	Np
6	*Withania coagulans* Dunal	15	21	90	17	18.3	13	40.6.c	Mic	Ch
7	*Prosopis cineraria* (L.) Druce	4	6.8	30	4.5	6	4.3	14.8	L	Np
8	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	2	3.8	20	2.2	3.3	2.9	8.4	Ap	Np
9	*Zizyphus nummularia* Burm.(f.) Wight &Arn.	3	8.6	20	3.4	7.5	2.9	13.8	N	Np
10	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	2	0.6	20	2.2	0.5	2.9	5.6	Mes	Ch
11	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	2	2.2	20	2.2	2	2.9	7.1	L	Ch
12	*Ficus carica* L.	2	5	20	2.2	4.4	2.9	9.5	Mes	Np
13	*Celtis eriocarpa* Decne.	3	2.5	30	3.4	2.2	4.3	9.9	N	Mp
14	*Calligonum polygonoides* L.	1	0.3	10	1.1	0.3	1.4	2.8	L	Np
B. Herbs layers										
15	*Fagonia critica* L.	7	1.8	40	7.9	1.6	5.8	15.3	L	Th
16	*Saccharum spontaneum* L.	4	1.5	26.7	4.5	1.3	3.9	9.7	L	Ch
17	*Coronopus didymus* (L.) Smith.	5	0.8	33.3	5.6	0.7	4.8	11.1	Mic	Th
Total		89	114.6	690	100	99.9	99.8	299.7		

Appendix 5. Phytosociological attributes of *Aerva - Rumex-Typha minima* at water courses during autumn 2008.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Tree Layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	1.3	40	2.4	1	6.1	9.5	L	Mp
2	*Tamarix aphylla* (L.) Karst	8	3.2	80	6.4	2.5	12.2	21.1	L	Mp
B. Shrubs layers										
3	*Prosopis cineraria* (L.) Druce	8	13.4	50	6.4	10.4	7.6	24.4	L	Np
4	*Prosopis juliflora* Swartz	4	4.1	30	3.2	3.4	4.6	11.2	L	Np
5	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	22	31	80	18	24.1	12.2	53.9.a	L	Ch
6	*Abutilon bidentatum* Hochst.ex A. Rich.	2	0.6	20	1.6	0.5	3	5.1	N	Ch
7	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	3	5.6	30	2.4	4.3	4.6	11.3	L	Ch
C. Herbs Layers										
8	*Eclipta alba* (L.) Hasskl	6	5.2	40	4.8	4	6	14.8	N	G
9	*Rumex obtisifolius* L.	26	17.3	93.3	21	13.4	14.2	48.5.b	Mic	G
10	*Solanum surattense* Burm. f.	6	2.7	33.3	4.8	2.1	5.1	12	N	H
11	*Polygonum patulum* M. Bieb.	11	3.8	53.3	8.8	6.8	8.1	19.9	N	G
12	*Achyranthes aspera* L.	7	2.3	26.7	5.6	1.8	4.1	11.5	N	Th
13	*Euphorbia prostrata* Ait.	6	4	26.7	4.8	3.1	4.1	12	L	Th
14	*Launaea nudicaulis* (L.) Hook. f	6	2.3	26.7	4.8	1.8	4.1	10.7	Mes	Th
15	*Typha minima* Funck ex Hoppe	7	31.7	26.7	5.6	24.7	4.1	34.4.c	Mes	G
Total		125	123.5	656.7	100	99.9	99.9	300		

Appendix 6. Phytosociological attributes of *Prosopis cineraria-Capparis-Prosopis farcta* at range lands during autumn 2008.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	6	4.1	60	5.7	3.6	8.6	17.9	L	Mp
B. Shrubs layers										
2	*Prosopis cineraria* (L.) Druce	18	28.4	90	16.9	24.7	12.9	54.5.a	L	Np
3	*Capparis decidua* (Forssk.) Edgew.	13	33.4	80	12.3	29	11.5	52.8.b	Ap	Np
4	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	6	9.7	60	5.7	8.4	8.6	22.7	L	Ch
5	*Salsola foetida* Del.ex Spreng.	6	4.7	50	5.7	4	7.2	16.9	L	Ch
6	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	5	4.3	40	4.7	3.7	5.7	14.1	Mes	Ch
7	*Prosopis farcta* (Banks & Sol.) Macbride.	18	24	90	16.9	20.8	12.9	50.6.c	L	Np
C. Herbs layers										
8	*Desmostachya bipinnata* (L.) Stapf.	6	1	40	5.7	0.9	5.7	12.3	N	H
9	*Viola stocksii* Boiss.	3	0.5	20	2.8	0.4	2.9	6.1	Mic	G
10	*Corchorus astuans* L.	4	1.5	26.7	3.8	1.3	3.8	8.9	L	Th
11	*Panicum antidotale* Retz.	6	1	40	5.6	0.8	5.8	12.2	N	H
12	*Aristida adscensionis* L.	7	1.1	46.6	6.8	1	6.7	14.3	Mic	H
13	*Halostachys belangerana* (Moq.) Botsch	8	1.4	53.4	7.6	1.2	7.6	16.4	L	Np
Total		106	115.1	696.7	100	99.8	99.9	299.6		

Appendix 7. Phytosociological attributies of *Tamarix dioca-Phoenix-Tamarix aphylla* community at water logged area during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees Layers										
1	*Phoenix dactylifera* L.	11	11.8	80	18	22.3	16.7	56.9.b	Mes	MP
2	*Tamarix aphylla* (L.) Karst	7	7.5	60	11.5	14.1	12.5	38.1.c	L	Mp
3	*Acacia nilotica* ssp. *nilotica* (L.) Delile	2	1.4	40	3.3	2.6	8.3	14.2	L	Mp
B. Shrubs Layers										
4	*Tamarix dioica* Roxb ex. Roth.	11	23.4	80	18	44.1	16.7	78.4.a	L	NP
5	*Prosopis cineraria* (L.) Druce	3	0.4	30	4.9	0.7	6.2	11.8	L	NP
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	4	1.2	40	6.5	2.2	8.3	17	L	Ch
7	*Salsola foetida* Del.ex Spreng.	2	0.6	20	3.3	1.1	4.2	8.6	L	Ch
8	*Vitex negundo* L.	1	0.3	10	1.6	0.6	2.1	4.3	N	Np
C. Herbs Layers										
9	*Cyprus rotundus* L.	5	1.8	33.3	8.2	3.4	6.9	18.5	N	G
10	*Aristida mutabilis* Trin & Rupr.	6	0.7	26.7	9.8	1.3	5.6	16.7	N	Th
11	*Typha latifolia* Edgew.	6	3.5	40	9.8	6.6	8.3	24.7	Mes	G
12	*Eclipta alba* (L.) Hasskl	3	0.5	20	4.9	0.9	4.2	10	N	G
Total		61	53.1	480	99.8	99.8	99.9	299.2		

Appendix 8. Phytosociological attributies of *Convolvulus-Chenopodium-Dicanthium* community near cultivated lands during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	7	12.5	80	5.1	18.8	10.7	34.2	L	Mp
2	*Zizyphus mauritiana* Lam.	3	1.9	40	2.2	2.9	5.1	10.2	N	Mp
3	*Tamarix aphylla* (L.) Karst	2	1	40	1.5	1.5	5.1	8.1	L	Mp
4	*Prosopis farcta* (Banks & Sol.) Macbride.	2	1.2	40	1.5	1.8	5.1	8.4	L	Mp
B. Shrubs layers										
5	*Zizyphus nummularia* Burm. (f.) Wight & Arn.	4	3.7	20	2.9	5.6	2.6	11.1	N	Np
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	5	2.8	40	3.7	4.2	5.1	13	L	Ch
7	*Salsola foetida* Del.ex Spreng.	1	3	10	0.7	0.4	1.3	2.4	L	Ch
8	*Atriplex griffithii* Moq.	4	1.2	40	2.9	1.8	5.1	9.8	N	Np
C. Herbs layers										
9	*Convolvulus arvensis* L.	29	8.8	86.7	21.3	13.3	11.2	45.8.a	N	Th
10	*Chenopodum album* L.	21	9.3	80	15.4	14	10.3	39.7.c	N	Th

11	*Dichanthium annulatum* (Forssk.) Stapf.	22	8.8	86.7	16.2	13.3	11.2	40.7.b	N	H
12	*Setaria verticillata* (L.) P. Beauv	5	2.5	33.3	3.7	3.8	4.3	11.8	L	Th
13	*Cenchrus biflorus* Roxb.	7	1.8	33.3	5.1	2.7	4.3	12.1	L	H
14	*Malva neglecta* Wallr.	4	1.5	26.7	2.9	2.3	3.4	8.6	Mic	Th
15	*Avena sativa* L.	6	2.5	33.3	4.4	3.8	4.3	12.5	N	Th
16	*Asphodelus tenuifolius* Cav.	3	0.5	20	2.2	0.7	2.6	5.5	L	G
17	*Polygonum plebejum* R. Br.	4	1.5	26.7	2.9	2.3	3.4	8.6	N	G
18	*Melilotus indica* (L.) All.	4	2.2	20	2.9	3.3	2.6	8.8	N	Th
19	*Reseda odorata* L.	3	1.3	20	2.2	2	2.6	6.8	N	Th
Total		136	65.3	76.7	99.7	99.5	99.9	299.9		

Appendix 9. Phytosociological attributies of *Asphodelus-Gastrocotyle-Hypericum* community at sandy area during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Prosopis farcta* (Banks & Sol.) Macbride	8	6.4	80	7.9	10.4	11	29.3	L	Mp
2	*Acacia nilotica* ssp. *nilotica* (L.) Delile	4	6.5	80	3.8	7.3	11	22.1	L	Mp
B. Shrubs layers										
3	*Salvadora oleoides* Decne.	4	2.8	40	3.9	4.5	5.5	13.9	N	Np
4	*Periploca calophylla* (Wight) Falc.	5	3.1	50	4.9	S4.9	6.8	16.6	Ap	Np
5	*Capparis decidua* (Forssk.) Edgew.	3	4.1	30	3	6.6	4.1	13.7	Ap	Np
6	*Prosopis cineraria* (L.) Druce	3	2.5	30	3	4	4.1	11.1	L	Np
7	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	3	0.9	30	3	1.4	4.1	8.6	Mes	Ch
C. Herbs layers										
8	*Asphodelus tenuifolius* Cav.	24	14.3	86.7	23.8	23.1	11.9	58.6.a	L	G
9	*Hypericum perforatum* L.	13	7.2	86.6	12.9	11.8	11.9	36.6.c	N	Ch
10	*Gastrocotyle hispida* (Forssk.) Bunge	15	9.7	86.7	14.9	15.7	11.9	42.5.b	Mic	H
11	*Echinochloa colona* (L.) Link	5	2.5	33.3	4.9	4	4.6	13.5	N	Th
12	*Emex australis* Steinh.	4	2.3	26.7	3.9	3.7	3.7	11.3	Mic	Th
13	*Saccharum spontaneum* L.	4	0.6	26.6	3.8	1	3.6	8.4	L	Ch
14	*Cleome brachycarpa* Vahl. ex DC.	6	1	40	6	1.6	5.4	13	N	Th
Total		101	61.9	726.7	99.7	99.9	99.6	299.5		

Appendix 10. Phytosociological attributes of *Salvadora-Periploca-Withania* at foothills during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia modesta* Wall.	4	1.5	40	5.2	2.1	6.9	14.2	L	Mp
2	*Acacia nilotica* ssp, *nilotica* (L.) Delile	4	2.7	60	5.2	3.8	10.3	19.3	L	Mp
B. Shrubs layers										
3	*Salvadora oleoides* Decne.	15	19.7	90	19.7	27.4	15.5	62.6.a	N	Np
4	*Periploca aphylla* Decne.	12	15	80	15.8	20.9	13.8	50.5.b	Ap	Np
5	*Periploca calophylla* (Wight) Falc.	2	0.6	20	2.6	0.8	3.4	6.8	Ap	Np
6	*Withania coagulans* Dunal	14	13.1	70	18.4	18.2	12.1	48.7.c	Mic	Ch
7	*Prosopis cineraria* (L.) Druce	3	4.1	30	3.9	5.7	5.2	14.8	L	Np
8	*Capparis decidua* (Forssk.) Edgew.	4	2.8	40	5.2	3.9	6.9	16	Ap	Np
9	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	2	3.7	20	2.6	5.1	3.4	11.1	N	Np
10	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	3	0.9	30	3.9	1.2	5.1	10.2	Mes	Ch
11	*Aerva javanica* (Burm. f.) Juss. ex J. A. Schultes	3	0.9	30	3.9	1.2	5.2	10.3	L	Ch
12	*Ficus carica* L.	3	2.2	20	3.9	3.1	3.4	10.4	Mes	Np
13	*Celtis eriocarpa* Decne.	3	2.1	20	3.9	3	3.4	10.3	N	Mp
14	*Calligonum polygonoides* L.	4	2.5	30	5.2	3.5	5.2	13.5	L	Np
Total		76	71.8	580	99.4	99.9	99.8	299.1		

Appendix 11. Phytosociological attributes of *Suaeda-Cyprus-Prosopis* at water courses during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	1.4	40	4.6	2.7	9.1	16.4	L	Mp
2	*Tamarix aphylla* (L.) Karst	5	0.8	33.3	7.7	1.5	7.6	16.8	L	Mp
B. Shrubs layers										
3	*Prosopis cineraria* (L.) Druce	5	10.6	50	7.7	20.1	1.4	39.2.c	L	Np
4	*Prosopis juliflora* Swartz	7	4.75	50	10.8	9	11.4	31.2	L	Np
5	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	4	2.4	30	6.1	4.6	6.8	17.6	L	Ch
6	*Abutilon bidentatum* Hochst.ex A. Rich	3	4.1	3	4.6	7.8	6.9	19.3	N	Ch
7	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	11	16.8	60	16.9	32	13.7	62.6.a	L	Ch
C. Herbs layers										
8	*Cyprus defformis* L.	17	6.8	80	26.1	13	18.3	57.4b	N	G
9	*Typha latifolia* Edgew.	6	2.5	33.3	9.2	4.7	7.6	21.5	Mes	G
10	*Poa annua* L.	4	2.4	30	6.1	4.6	6.8	17.6	L	Th
Total		65	52.6	436.6	99.9	100	99.7	299.7		

Appendix 12. Phytosociological attributes of *Capparis-Callotropis-Prosopis* community at range lands during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	5	3.7	60	6.2	4.1	10.4	20.7	L	Mp
B. Shrubs layers										
2	*Prosopis cineraria* (L.) Druce	14	20.3	80	17.5	22.2	13.9	53.6.c	L	Np
3	*Capparis decidua* (Forssk.) Edgew.	9	23.5	70	11.2	35.6	12.1	58.8.a	Ap	Np
4	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	5	4.4	40	6.2	4.8	6.9	17.9	L	Ch
5	*Salsola foetida* Del.ex Spreng.	5	4.6	50	6.2	5	8.7	19.9	L	Ch
6	*Prosopis farcta* (Banks & Sol.) Macbride.	4	4.3	40	5	4.7	6.9	16.6	L	Np
7	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	16	18.1	90	120	19.8	15.6	55.4.b	Mes	Ch
C. Herbs layers										
8	*Cynodon dactylon* (L.) Pers.	5	0.8	33.3	6.2	0.9	6.1	13.2	L	H
9	*Dichanthium annulatum* (Forssk.) Stapf.	6	1	40	7.5	1.1	6.9	15.5	N	H
10	*Poa annua* L.	4	0.6	26.6	5	0.6	4.6	10.2	L	Th
11	*Cenchrus ciliaris* L.	7	1.1	46.7	8.7	1.1	8.1	17.9	L	H
Total		80	91.1	576.6	100	99.7	99.9	299.7		

Appendix 12. Phytosociological attributes of *Capparis-Callotropis-Prosopis* community at range lands during winter 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	5	3.7	60	6.2	4.1	10.4	20.7	L	Mp
B. Shrubs layers										
2	*Prosopis cineraria* (L.) Druce	14	20.3	80	17.5	22.2	13.9	53.6.c	L	Np
3	*Capparis decidua* (Forssk.) Edgew.	9	23.5	70	11.2	35.6	12.1	58.8.a	Ap	Np
4	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	5	4.4	40	6.2	4.8	6.9	17.9	L	Ch
5	*Salsola foetida* Del.ex Spreng.	5	4.6	50	6.2	5	8.7	19.9	L	Ch
6	*Prosopis farcta* (Banks & Sol.) Macbride.	4	4.3	40	5	4.7	6.9	16.6	L	Np
7	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	16	18.1	90	120	19.8	15.6	55.4.b	Mes	Ch
C. Herbs layers										
8	*Cynodon dactylon* (L.) Pers.	5	0.8	33.3	6.2	0.9	6.1	13.2	L	H
9	*Dichanthium annulatum* (Forssk.) Stapf.	6	1	40	7.5	1.1	6.9	15.5	N	H
10	*Poa annua* L.	4	0.6	26.6	5	0.6	4.6	10.2	L	Th
11	*Cenchrus ciliaris* L.	7	1.1	46.7	8.7	1.1	8.1	17.9	L	H
Total		80	91.1	576.6	100	99.7	99.9	299.7		

Appendix 13. Phytosociological attributies of *Tamarix-Suaeda-Typha* community at water logged area during spring 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Phoenix dactylifera*	11	11.8	80	9.9	13.4	11.2	34.5	Mes	MP
2	*Tamarix aphylla* (L.) Karst	8	9.3	80	7.2	10.5	11.2	28.9	L	Mp
3	*Acacia nilotica* ssp. *nilotica* (L.) Delile	1	1.4	20	0.9	1.6	2.8	5.3	L	Mp
B. Shrubs layers										
4	*Tamarix dioica* Roxb ex. Roth.	12	28.4	90	10.8	32.2	12.5	55.5.a	L	NP
5	*Prosopis cineraria* (L.) Druce	4	4.3	40	3.6	4.9	5.6	14.1	L	NP
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	18	17.6	80	16.2	20	11.2	47.4.b	L	Ch
7	*Salsola foetida* Del.ex Spreng.	2	0.6	20	1.8	0.7	2.8	5.3	L	Ch
8	*Vitex negundo* L.	2	0.6	20	1.8	0.7	2.8	5.3	N	Np
C. Herbs layers										
9	*Desmostachya bipinnata* (L.) Stapf.	4	0.6	26.7	3.6	0.7	3.7	8	N	H
10	*Aristida mutabilis* Trin & Rupr.	3	0.5	20	2.7	0.6	2.8	6.1	N	Th
11	*Datura alba* Nees	1	1	6.7	0.9	1.1	0.9	2.9	Mic	Th

12	*Typha latifolia* Edgew.	22	4.5	80	19.8	5.1	11.2	36.1.c	Mes	G
13	*Phragmites karka* (Retz.) Trin. ex Steud.	5	0.7	33.3	4.5	0.8	4.6	9.9	Mes	Ch
14	*Eclipta alba* (L.) Hasskl	2	0.3	13.3	1.8	0.3	1.8	3.9	N	G
15	*Rumex obtisifolius* L.	2	0.3	13.3	1.8	0.3	1.8	3.9	Mes	G
16	*Euphorbia helioscopia* L.	1	0.2	6.7	0.9	0.2	0.9	2	L	H
17	*Echinchloa colona* (L.) Link.	3	0.5	20	2.7	0.6	2.8	6.1	N	Th
18	*Heliotropium europaeum* L.	4	2	26.7	3.6	2.3	3.7	9.6	Mic	Th
19	*Urtica pilulifera* L.	4	2.3	26.7	3.6	2.6	3.7	9.9	Mic	G
20	*Cyprus defformis* L.	2	1.2	13.3	1.8	1.4	1.8	5	N	G
Total		111	88.1	716.7	99.9	99.3	99.8	299.7		

Appendix 14. Phytosociological attributies of *Euporbia-Medicago-Malva* community near cultivated land during spring 2009.

S.No.		Density	Cover	Frequency	RD	RC	RF	IV	Lea size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	7	10.3	80	4.9	15	9.3	28.7	L	Mp
2	*Zizyphus mauritiana* Lam.	2	2.1	40	1.4	3	4.7	9.1	N	Mp
3	*Tamarix aphylla* (L.) Karst	2	1.8	40	1.4	2.5	4.7	8.6	L	Mp
4	*Prosopis farcta* (Banks & Sol.) Macbride.	1	1.9	20	0.7	2.7	2.3	5.7	L	Mp
B. Shrubs layers										
5	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	3	2.2	40	2.1	3.1	4.7	9.9	N	Np
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	5	2.5	30	3.5	3.5	3.5	10.5	L	Ch
7	*Salsola foetida* Del.ex Spreng.	2	0.6	20	1.4	0.8	2.3	4.5	L	Ch
8	*Atriplex griffithii* Moq.	4	1.2	40	2.8	1.7	4.7	9.2	N	Np
C. Herbs layers										
9	*Euporbia helioscopia* L.	24	14	93.3	16.9	20	10.9	47.5.a	L	Th
10	*Malva neglecta* Wallr.	17	10	80	12.1	14	9.3	35.4.c	Mic	Th

11	*Medicago polimorpha* L.	29	6.5	93.3	20.4	9.2	10.9	40.5.b	N	Th
12	*Lathyrus aphaca* L.	8	3.5	40	5.6	5.9	4.7	16.2	N	Th
13	*Cynodon dactylon* (L.) Pers.	4	2.3	26.7	2.8	3.2	3.1	9.1	L	H
14	*Chenopodium ambrosioides* L.	5	1.7	33.3	3.5	2.4	3.9	9.8	L	Th
15	*Vicia faba* L.	4	1.5	26.7	2.8	2.1	3.1	8	N	Th
16	*Anethum graveolens* L.	5	1.6	33.3	3.5	2.2	3.9	9.6	L	Th
17	*Oligomeris linifolia* (Vahl.) Macbride.	4	3.2	26.7	2.8	4.5	3.1	10.4	N	Th
18	*Melilotus* indica (L.) All.	7	1.7	33.3	4.9	2.4	3.9	11.2	N	Th
19	*Medicago minima* (L.) Grufb	6	1	40	4.2	1.4	4.7	10.3	N	Th
20	*Chenopodium album* L.	3	1.3	20	2.1	1.8	2.3	6.2	N	Th
Total		142	70.9	856.6	99.9	100	99.9	299.8		

Appendix 15. Phytosociological attributes of *Arnebia -Psammogeton-Malcolmia* at sandy area during spring 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layer										
1	*Prosopis farcta* (Banks & Sol.) Macbride	6	4.3	60	4	4.6	6.6	15.2	L	Mp
2	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	3.5	60	2	3.8	6.5	12.3	L	Mp
B. Shrubs layers										
3	*Salvadora oleoides* Decne	3	4.1	30	2	4.4	3.3	9.7	N	Np
4	*Periploca calophylla* (Wight) Falc.	6	3.4	60	4	3.7	6.6	14.3	Ap	Np
5	*Capparis decidua* (Forssk.) Edgew.	5	5.6	30	3.3	6.1	3.3	12.7	Ap	Np
6	*Prosopis cineraria* (L.) Druce	3	4.1	30	2	4.4	3.3	9.7	L	Np
7	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	5	4.4	40	3.3	4.8	4.4	12.7	Mes	Ch
C. Hrebs layers										
8	*Arnebia hispidissima* (Lehm.) A. DC.	25	15.3	93.3	16.5	16.6	10.2	43.3.a	L	Th

9	*Psammogeton biternatum* Edgew.	20	10.3	86.7	13.2	11.1	9.5	33.8.b	L	Th
10	*Malcolmia africana* (L.) R. Br.	19	12.8	86.7	12.6	13.9	9.5	33.8.c	N	Th
11	*Arnebia guttata* Bunge	12	4.9	86.7	6.9	5.3	7.2	18.55	L	Th
12	*Astragalus amherstianus* Royle ex Benth.	7	3.2	26.7	4.6	3.5	2.9	11	L	Ch
13	*Boerhavia procumbens* Banks ex Roxb.	6	1.5	40	4	1.6	4.4	10	L	Ch
14	*Emex spinosus* (L.) Campd.	6	2.7	40	4	3	4.4	11.4	Mic	Th
15	*Tricholepis chaetolepis* (Boiss.) Rech.f.	6	3.5	40	4	3.7	4.4	12.1	L	Th
16	*Eragrostis minor* Host	5	2.3	26.7	3.3	2.5	3	8.8	N	Th
17	*Ochthochloa compressa* (Forssk.) Hilu	2	2	13.3	1.3	2.2	1.5	5	N	H
18	*Medicago minima* (L.) Grufb	3	0.5	20	2	0.5	2.2	4.7	N	Th
19	*Cymbopogon jwarancusa* (Jones) Schultes	3	1.3	20	2	1.4	2.2	5.6	N	H
20	*Sonchus asper* (L.) Hill.	6	2.6	40	4	2.8	4.4	11.2	Mic	Th
Total		151	92.3	910.1	99.9	99.9	99.9	299.9		

Appendix 16. Phytosociological attributes of *Salvadora-Withania-Periploca* at foothills during spring 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia modesta* Wall.	4	2.1	40	4.3	2	6	12.3	L	Mp
2	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	4	60	3.3	3.7	9	16	L	Mp
B. Shrubs la|yers										
3	*Salvadora oleoides* Decne.	16	36.2	90	17.4	33.2	13.4	64.6.a	N	Np
4	*Periploca aphylla* Decne.	12	18.7	80	13	17.5	12	42.5.c	Ap	Np
5	*Periploca calophylla* (Wight) Falc.	2	0.6	20	2.2	0.6	2.9	5.7	Ap	Np
6	*Withania coagulans* Dunal	15	17.8	80	16.3	16.7	11.9	44.9.b	Mic	Ch
7	*Prosopis cineraria* (L.) Druce	2	2.2	20	2.2	2	2.9	7.1	L	Np
8	*Capparis decidua* (Forssk.) Edgew.	2	2,.2	20	2.2	2	2.9	7.1	Ap	Np
9	*Zizyphus numularia* Burm. (f.) Wight & Arn.	2	3.7	20	2.2	3.5	2.9	8.6	N	Np
10	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	3	1	30	3.3	1	4.4	8.7	Mes	Ch
11	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	2	2.2	20	2.2	2	2.9	7.1	L	Ch
12	*Ficus carica* L.	1	0.3	10	1.1	0.3	1.5	2.9	Mes	Np
13	*Celtis eriocarpa* Decne.	3	2.2	20	3.3	2	2.9	8.2	N	Mp

14	*Calligonum polygonoides* L.	3	1	30	3.3	1	4.4	8.7	L	Np
C. Herbs layers										
15	*Peganum harmala* L.	4	3.2	26.7	4.3	3	4	11.3	L	H
16	*Fumaria indica* (Hausskn.) Pugsley	4	1.5	26.7	4.3	1.4	4	9.7	N	Th
17	*Euphorbia dracunculoides* Lam.	3	2.2	20	3.2	2	3	8.2	L	H
18	*Portulaca quadrifida* L.	4	1.3	20	4.3	3	4	8.5	N	Th
19	*Spergularia rubra* (L.) Griseb.	4	3.2	26.7	4.3	3	4	11.3	L	Th
20	*Spergula arvensis* L.	3	1.2	13.3	3.2	1.1	2	6.3	N	Th
Total		92	107	513.4	99.9	99.8	99.9	299.7		

Appendix 17. Phytosociological attributes of *Taraxacum-Tamarix-Suaeda* community at water courses during spring 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	1.1	4	2.3	1.2	5	8.5	L	Mp
2	*Tamarix aphylla* (L.) Karst	11	6	80	8.5	6.6	10	25.1 b	L	Mp
B. Shrubs layers										
3	*Prosopis cineraria* (L.) Druce	7	9.7	60	5.4	10.1	17.5	23	L	Np
4	*Prosopis juliflora* Swartz	3	2.5	30	2.3	2.8	3.8	8.9	L	Np
5	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	6	9.3	35	4.6	10.3	4.4	24.5	L	Ch
6	*Abutilon bidentatum* Hochst.ex A.Rich.	3	2.2	30	2.3	2.4	3.8	8.5	N	Ch
7	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	6	9.3	35	4.6	10.3	4.4	24.5.c	L	Ch
C. Herbs layers										
8	*Solanum nigrum* L.	8	4.5	46.7	6.1	5	5.9	17	Mic	Th
9	*Taraxacum officinale* F. H. Wigg.	16	10.2	80	12.3	11.3	10	33.6.a	Mic	Th
10	*Imperata cylindrica* L.	5	4.7	33.3	3.8	5.2	4.2	13.2	L	G
11	*Rumex dentatus* L.	4	2.3	26.7	3.1	2.5	3.3	8.9	Mes	G
12	*Polygonum plebejum* R. Br.	4	3	20	3.1	3.3	2.5	8.9	N	H
13	*Plantago lanceolata* L.	6	6	40	4.6	6.6	5	16.2	N	Th
14	*Veronica biloba* L.	2	1.2	13.3	1.5	1.3	1.7	4.5	N	Th

15	*Plantago major* L.	2	1.2	13.3	1.5	1.3	1.7	4.5	Mic	Th
16	*Veronica aqutica* Bern.	8	4.2	33.3	6.1	4.6	4.2	14.9	N	Th
17	*Schismus barbatus* (L.) Thell.	9	3	53.3	7	3.3	4.2	14.5	N	H
18	*Ranunculus scleratus* L.	8	4.3	40	6.1	4.8	5	15.9	Mic	G
19	*Equsetum arvense* L.	8	2.2	54.3	6.2	2.5	6.6	15.3	Ap	G
20	*Malvastrum coromandelianum* (L.) Garcke	5	1.5	26.7	3.8	1.7	3.3	8.8	N	H
21	*Heliotropium europaeum* L.	6	1.7	33.3	4.6	1.9	4.2	10.7	Mic	Th
Total		130	90.2	796.6	99.8	99.1`	99.7	299.6		

Appendix 18. Phytosociological attributes of *Prosopis-Suaeda-Capparis* community at range lands during spring 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	4	3.9	60	2.8	2.9	6.6	12.3	L	Mp
B. Shrubs layer										
2	*Prosopis cineraria* (L.) Druce	19	36	90	13.4	26.7	9.9	50.0.a	L	Np
3	*Capparis decidua* (Forssk.) Edgew.	9	30	70	6.3	12.2	7.7	36.2.c	Ap	Np
4	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	20	20	90	14	14.8	9.9	38.7.b	L	Ch
5	*Salsola foetida* Del.ex Spreng.	7	6.6	60	4.9	4.9	6.6	16.4	L	Ch
6	*Prosopis farcta* (Banks & Sol.) Macbride.	5	3.1	50	3.5	2.3	5.5	11.3	L	Np
7	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	8	3.4	60	5.6	2.5	6.6	14.7	Mes	Ch
C. Herbs layers										
8	*Xanthium strumarium* L.	9	5.5	53.3	6.3	4	5.9	16.2	N	Th
9	*Euphorbia prostrata* Ait.	4	0.7	26.7	2.8	0.5	2.9	6.2	L	Th
10	*Launea nudicaulis* (L.) Hook.f.	8	2	33.3	5.6	1.5	3.7	10.8	Mes	Th
11	*Conyza canadensis* (L.) Cronquist	8	4.2	33.3	5.6	3.1	3.7	12.4	Mic	Th
12	*Eragrostis minor* Host	5	3.3	33.3	3.5	2.4	3.7	9.6	N	Th
13	*Malva neglecta* Wallr.	5	3.3	33.3	3.5	2.4	3.7	9.6	Mic	Th
14	*Medicago minima* (L.) Grufb	6	2.7	40	4.2	2	4.4	10.6	N	Th
15	*Sclerochloa dura* (L.) P. Beauv.	9	3.8	53.4	6.3	2.8	5.8	14.9	N	Th
16	*Panicum capillare* L.	7	5	60	4.9	3.7	6.6	15.2	N	Th
17	*Aristida mutabilis* Trin & Rupr.	6	1.5	60	6.3	1.1	6.6	14	N	Th
Total		142	135	906.6	99.5	99.8	99.8	299.1		

Appendix 19. Phytosociological attributies of *Tamarix-Suaeda-Phoenix* community at water logged area during summer 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Phoenix dactylifera* L.	12	9.9	80	12.1	10.2	12	34.3	Mes	MP
2	*Tamarix aphylla* (L.) Karst	7	5.8	80	7.1	6	12	25.1	L	Mp
3	*Acacia nilotica* ssp. *nilotica* (L.) Delile	1	1.5	20	1	1.5	3	5.5	L	Mp
B. Shrubs layers										
4	*Tamarix dioica* Roxb. ex. Roth.	12	34.1	90	12.1	35.2	13.5	60.8	L	NP
5	*Prosopis cineraria* (L.) Druce	5	7.8	50	5	8	7.5	20.5	L	NP
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	16	20.6	80	16.2	21.2	12	49.4	L	Ch
7	*Salsola foetida* Del.ex Spreng.	2	3.7	20	2	3.8	3	8.8	L	Ch
8	*Vitex negundo* L .	2	2.2	20	2	2.3	3	7.3	N	Np
C. Herbs layers										
9	*Typha latifolia* Edgew.	18	4.3	73.3	18.2	4.4	11	33.6	Mes	G
10	*Phragmites karka* (Retz.) Trin. ex Steud.	7	4.3	40	7.1	4.4	6	17.5	Mes	Ch
11	*Aristida cyanantha* Nees ex Steud.	4	0.6	26.7	4	0.6	4	8.6	Mic	H
12	*Ranunculus scleratus* L.	2	0.4	13.4	2	0.4	2	4.4	Mic	G
13	*Oxystelma esculentum* (L. f.) R. Brown	6	1	40	6.1	1	6	13.1	L	Ch
14	*Amaranthus graecizans* L.	5	0.7	33.3	5	0.7	5	10.7	L	Th
Total		99	96.9	666.7	99.9	99.7	99.9	300		

Appendix 20. Phytosociological attributies of *Alhagi-Suaeda-Cousinia* community near cultivated land during summer 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	7	8.8	80	7.5	16.7	13	37	L	Mp
2	*Zizyphus mauritiana* Lam.	3	1.8	60	3.2	3.4	9.5	16.1	N	Mp
3	*Tamarix aphylla* (L.) Karst	2	1.1	40	2.1	2.1	6.3	10.5	L	M
4	*Prosopis farcta* (Banks & Sol.) Macbride.	2	1	40	2.1	1.9	6.3	10.3	L	Mp
B. Shrubs layres										
5	*Zizyphus nummularia* Burm.(f.) Wight & Arn.	3	2.2	20	3.2	4.2	3.2	10.6	N	Np
6	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	11	8.7	80	12	16.5	13	41.1.c	L	Ch
7	*Salsola foetida* Del.ex Spreng.	3	1	30	3.2	1.8	4.8	9.8	L	Ch
8	*Atriplex griffithii* Moq.	3	4.1	30	3.2	7.8	4.8	15.8	N	Np
C. Herbs layers										
9	*Alhagi maurorum* Medic.	22	8.5	80	24	16.1	13	52.5.a	L	H
10	*Cousinia minuta* Boiss.	18	10.5	66.7	19	20	11	49.9.b	N	Th
11	*Malva neglecta* Wallr.	2	0.3	13.3	2.1	0.6	2.1	4.8	Mic	Th
12	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	6	1	40	6.4	1.8	6.4	14.6	N	H
13	*Medicago minima* (L.) Grufb	4	2	13.3	4.3	3.8	2.1	10.2	N	Th
14	*Phalaris aquatica* L.	7	1.7	33.3	7.5	3.2	5.3	16	N	G
Total		93	52.7	626.6	100	99..9	100	299.2		

Appendix 21. Phytosociological attributes of *Cenchrus-Cousinia-Prosopis* at sandy area during summer 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Prosopis farcta* (Banks & Sol.) Macbride.	5	5.2	60	4.8	9.4	9.4	23.6.c	L	Mp
2	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	4.1	60	3	7.4	9.3	19.7	L	Mp
B. Shrubs layers										
3	*Salvadora oleoides* Decne.	3	1	30	2.9	1.8	4.7	9.4	N	Np
4	*Periploca calophylla* (Wight) Falc.	2	3	20	1.9	5.4	3.1	10.4	Ap	Np
5	*Capparis decidua* (Forssk.) Edgew.	4	5.6	30	3.8	10	4.7	18.6	Ap	Np
6	*Prosopis cineraria* (L.) Druce	4	6	40	3.8	11	6.2	20.8	L	Np
7	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	4	2.8	40	3.8	5	6.2	15	Mes	Ch
C. Herbs layers										
8	*Cenchrus ciliaris* L.	23	12.2	86.7	22.1	22	13.5	57.6.a	L	H
9	*Cousinia minuta* Boiss.	23	11.7	80	22.1	21	12.5	55.7.b	N	Th
10	*Psammogeton biternatum* Edgew.	7	2	46.7	6.7	3.6	7.3	17.6	L	Th
11	*Cyprus rotundus* L.	3	0.5	20	2.9	0.9	3.1	6.9	N	G
12	*Sclerochloa dura* (L.) P. Beauv.	6	1.3	20	5.8	2.3	3.1	11.2	N	Th
13	*Crambe cordifolia* Steven	5	0.8	33.3	4.8	1.4	5.2	11.4	Mic	Th
14	*Chrozophora tinctoria* (L.) Raf.	4	0.7	26.7	3.8	1.3	4.1	9.2	Mic	Th
15	*Alhagi maurorum* Medic.	10	1.5	66.6	9.6	2.7	10.4	11.3	L	H
Total		104	55.4	640	99.9	100	99.7	299.4		

Appendix 22. Phytosociological attributes of *Salvadora-Withania-Prosopis* at foothills during summer 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia modesta* Wall.	5	1.9	60	5.3	1.5	8.2	15	L	Mp
2	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	2.9	60	3.1	2.3	8.2	13.6	L	Mp
B. Shrubs layers										
3	*Salvadora oleoides* Decne.	16	44.1	90	16.8	34.6	12.3	63.7.a	N	Np
4	*Periploca aphylla* Decne.	6	7.8	50	6.3	6.1	6.8	19.2	Ap	Np
5	*Periploca calophylla* (Wight) Falc.	3	4.1	30	3.1	3.2	4.1	10.4	Ap	Np
6	*Withania coagulans* Dunal	14	21.6	70	14.7	17	9.5	41.2.b	Mic	Ch
7	*Prosopis cineraria* (L.) Druce	11	21.9	80	11.6	17.2	11	39.8.c	L	Np
8	*Capparis decidua* (Forssk.) Edgew.	2	2.2	20	2.1	1.7	2.7	6.5	Ap	Np
9	*Zizyphus nummularia* Burm. (f.) Wight & Arn.	2	6.6	20	2.1	5.2	2.7	10	N	Np
10	*Calotropis procera* ssp. *hamiltonii* (Wight) Ali	1	0.3	10	1	0.2	1.4	2.6	Mes	Ch
11	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	3	2.5	30	3.1	2	4.1	9.2	L	Ch
12	*Ficus carica* L.	2	0.6	20	2.1	0.5	2.7	5.3	Mes	Np
13	*Celtis eriocarpa* Decne.	4	4.1	30	4.2	3.2	4.1	11.5	N	Mp
14	*Calligonum polygonoides* L.	5	1.6	50	5.3	1.2	6.8	13.3	L	Np
C. Herbs layer										
15	*Echinochloa crus-galli* (L.) P. Beauv.	6	1	40	6.3	0.8	5.4	12.5	N	Th
16	*Plantago ciliata* ssp. *lanata* (Boiss.) Rech.	4	1.3	20	4.2	1	2.7	7.9	N	Th
17	*Plantago lanceolata* L.	5	2.5	33.3	5.3	2	4.5	11.8	N	Th
18	*Anagallis arvensis* L.	3	0.5	20	3.1	0.4	2.7	6.2	N	Th
Total		95	127.5	733.3	99.7	99.9	99.9	299.6		

Appendix 23. Phytosociological attributes of *Typha-Tamarix-Chrozophora* at water courses during summer 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	3	1.5	60	2.1	1.5	8.2	1.8	L	Mp
2	*Tamarix aphylla* (L.) Karst	10	5.3	100	7.1	5.4	13.7	26.2.b	L	Mp
B. Shrubs layers										
3	*Prosopis cineraria* (L.) Druce	10	9.4	47.4	7.1	9.5	6.5	23.1	L	Np
4	*Prosopis juliflora* Swartz	4	2.3	26.7	2.8	2.3	3.6	8.7	L	Np
5	*Aerva javanica* (Burm. f.) Juss. ex J.A. Schultes	9	8.4	42.6	6.4	8.6	5.8	20.8	L	Ch
6	*Abutilon bidentatum* Hochst.ex A.Rich.	4	0.7	26.7	2.8	0.7	3.6	7.1	N	Ch
7	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	7	7.5	40	5	7.6	5.5	18.1	L	Ch
C. Herbs layers										
8	*Typha minima* Funck ex Hoppe	27	19.5	80	19.1	19.8	11	49.9.a	Mes	G
9	*Trianthema portulacastrum* L.	12	3	46.7	8.5	3	6.4	17.9	N	Th
10	*Conyza canadensis* (L.) Cronquist	9	5	33.3	6.4	5.1	4.6	16.1	Mic	Th
11	*Slanum nigrum* L.	7	4.3	40	5	4.4	5.5	14.9	Mic	Th
12	*Veronica biloba* L.	10	4.6	60	7	4.6	8.2	19.8	N	Th
13	*Taraxacum officinale* F. H. Wigg.	7	4.2	40	5	4.3	5,.5	14.8	Mic	Th
14	*Amaranthus graecizans* L.	5	5	26.7	3.5	5.1	3.6	12.2	L	Th
15	*Chrozophora oblongifolia* (Del.) Adr. Juss. ex Spreng.	9	13.7	33.3	6.4	14	4.6	25.0.c	N	H
16	*Plantago major* L.	8	4	26.7	5.7	4.1	3.6	13.4	Mic	Th
Total		141	98.4	730.1	99.9	99.9	99.9	299.8		

Appendix 24. Phytosociological attributes of *Capparis-Prosopis-Suaeda* at range lands during summer 2009.

S.No.	Plant species	Density	Cover	Frequency	RD	RC	RF	IV	Leaf size	Life form
A. Trees layers										
1	*Acacia nilotica* ssp. *nilotica* (L.) Delile	4	4.1	60	4.1	4.4	8.5	17	L	Mp
B. Shrubs layers										
2	*Prosopis cineraria* (L.) Druce	15	20.6	80	15.5	22.1	11.3	48.9.b	L	Np
3	*Capparis decidua* (Forssk.) Edgew.	10	28.1	80	10.3	30.1	11.3	51.7.a	Ap	Np
4	*Suaeda fruticosa* Forssk. ex J. F. Gmelin	12	13.4	80	12.4	14.4	11.3	38.1.c	L	Ch
5	*Salsola foetida* Del.ex Spreng.	4	1.2	40	4.1	1.3	5.7	11.1	L	Ch
6	*Prosopis farcta* (Banks & Sol.) Macbride.	5	6.2	50	5.1	6.6	7	18.7	L	Np
7	*Calotropis procera* subsp. *hamiltonii* (Wight) Ali	10	8.4	70	10.3	9	9.9	29.2	Mes	Ch
C. Herbs layers										
8	*Cynodon dactylon* (L.) Pers.	10	1.7	66.7	10.3	1.8	9.4	21.5	L	H
9	*Poa infirma* H. B. K.	5	0.8	33.3	5.2	0.8	4.7	10.7	L	Th
10	*Fumaria indica* (Hausskn.) Pugsley	5	1.7	33.3	5.1	1.8	4.7	11.6	N	Th
11	*Convolvulus microphyllus* Sieb.ex Spreng.	6	2.7	40	6.2	2.9	5.7	14.8	N	Th
12	*Pulicaria crispa* (Forssk.) BH.	5	0.8	33.3	5.2	0.8	4.7	10.7	L	H
13	*Convolvulus prostratus* Forssk.	6	3.5	40	6.2	3.8	5.6	15.6	L	Th
Total		97	93	706.6	100	99.8	99.8	299.6		