CHAPTER 3
MATERIALS AND METHODS

Experimental site

The present study was carried out at the Central Research Farm of Indian Grassland and Fodder Research Institute, Jhansi (25° 31’ N latitude and 78° 32’ E longitude and about 226 MSL) located in the Bundelkhand region. The region comprises some part of Uttar pradesh (24° 11’-26° 27’ N latitude and 78° 34’ E longitude) and Madhya pradesh 24° 40’-26° 50’ N latitude and 76° 80’-80° 50’ E longitude). According to Tyagi (1997) the total geographical area of the region is 71618 square Kilometer. The human population is over 12 million and the livestock population is 9.43 million, which include 5.36 million cattle, 1.64 million buffaloes, 1.83 million goats, 0.42 million sheep and 0.2 million other animals. Its intermixed undulating areas of varied slope characterize the topography of the region. The distribution of rainfall is often erratic, in August and July of the total about 70 percent rainfall occurred and about 90 percent of the total precipitation occurs between mid June to end of September. The rainfall varies between 750 mm in northwest to about 1200 mm in southwest. May and June are the hottest months with maximum temperature of 43-46° c and the January is the coldest month and recorded minimum temperature 3-4° c.
Plate-I  Study site with the lay out of the experiment

Plate-II  Mixed herd grazing in rotational grazing system plot
NET WORK PROGRAMME ON CROP BASED LIVESTOCK PRODUCTION SYSTEM

Grazing Systems         Plot No.
Rotational             4, 6, 11 & 15
Deferred rotational    3, 5, 9 & 13
Continuous             2, 7, 10 & 16
cut & carry            1, 8, 12 & 14
Standard control       17
The Bundelkhand area is termed as semi-arid region. The region has two major soil groups. Red soils are coarse and are found generally in Jhansi and Lalitpur Districts of U.P. where as Jalaun, Hamirpur, Mahoba, Sahujmaharajnagar and Banda district of U.P. have heavy black soils. These red and black soils are further classified into Rakar, Parwa, Kabar and Mar groups. Generally, poor nitrogen, medium phosphorus and high potash contents are found in red type of soil. In this area the rivers like Betwa, Jhassan, Ken, Chandrawal and Pahuj provide water for irrigation. In this region about 30 percent of geographical area is covered by forests, none agriculture use land, barren and uncultivated land, cultivated wasteland, other fallow lands. About 43.2 percent area of this region is net sown area and about 29.8 percent of the net sown area is under irrigation. According by Ghosh (1991) the forest area of this region is about 16 percent of total geographical area. The vegetation of this region is tropical dry deciduous. Some selected areas in the forest are used for grazing by animals. The fallow lands, which are uncultivated due to various reasons, are used for growing grasses during rainy season and harvested mature grasses are conserved as hay or silage. After harvesting, these areas are opened for stubble grazing for limited period.

The period of this study was from June 1998 to May 2000. Present studies were under taken to analyze the vegetation dynamics of a grassland ecosystem under four grazing systems viz., rotational, deferred rotational, continuous grazing and cut & carry systems. Each system was replicated four times in RBD. The plot size is 1 ha each.

Microsite-1: - Plot no 4,6,11&15 for rotational grazing
Microsite-2: - Plot no.3, 5,9 &13 for deferred rotational grazing
Microsite-3: - Plot no.2, 7,10 &16 for continuous grazing
Microsite-4: - Plot no 1,8,12 &14 for Cut & Carry system

Climate

The study area falls under semiarid region. The climate is monsoon type and is characterized by dry summer, hot rainy season, warm autumn and cool winter. The average rainfall for study period was about 945 mm and 90 percent of the total rainfall occurred between July to September. June was the hottest month with mean maximum temperature 39.1°C and January was the coldest month with mean minimum temperature
of 5.1°C. Table No.1 Shown some meteorological parameters during study period. It is evident that Relative Humidity almost followed the patterns of rainfall and temperature. May shared lowest relative humidity followed by June. The wind velocity was maximum during June followed by May and July. Brightness or sunshine was most during May followed by April and February. The sunshine was least during December. The rate of evaporation was higher than rainfall during month of January and February and droughtness due to higher evaporation need compared to rainfall receipt during these months. Maximum evaporation was recorded during May followed by June.

**Soil Study**

The soil of the area is variable and major part is covered with red gravely type of soil (alfi sols) with good porosity and drainage and some places had black loamy patches, semi rocky substratum, hillock areas. The texture, pH and available nutrients of study site are varied. The soil was almost neutral and soil nutrient status was of low to medium range.

**Plant Study**

**Pasture Improvement**

**Grasses**

1. *Cenchrus ciliaris* Linn. (*Anjan ghas*)

This genus belongs to the tribe panicae in which the two flowered spikelets fall ripe leaving no glumes. The spikelets are solitary and pedicels are never swollen. It is commonly known as buffel or Anjan grass and is very palatable at maturity. It makes reasonable quality hay when cut in early flowering stage.

2. *Cenchrus setigerus* Vahl. (*Dhaman ghas*)

It is selection from exotic material and adapted well to arid and semiarid regions of India. It is a drought hardy, early maturing, high tillering, quick generation ability, capable of giving 2-3 cuts in a year. Its averaged yield is 40 q/ha green fodder and 15 q/ha dry matter under arid condition. It is a leafy and highly nutritious for all kinds of livestock. In India it is called as Dhaman grass. Its drought resistance, hardiness, palatable and help in erosion control. The grass once established, with stands grazing
well and cutting 30 days intervals gave highest yield in Rajasthan and cutting frequencies at height (5, 10 or 15 Cm) make no difference in this grass species.

3. Chrysopegon fulvus (Spreng) Chiv. (Dholu ghas)

It has densely tufted culms with long linear acuminate leaves. It is commonly known as Dholu grass. The grass is a valuable fodder and is cut just before flowering. It may also be used as a sand binder.

4. Dichanthium annulatum (Forsk) (Kel ghas)

It is commonly known as Kel ghas. It is palatable and used as hay in India. It has slender erect culms, nodes usually bearded, two or four racemes erect and rather close, pedunculate, first glume of the spikelet not indurates. Stalks of recemes hairy, pedicillate, spikelet usually male or bisexual, some time’s neuter but with both glumes well developed and often with lemmas (Skerman and Riveros, 1992). It is widely adaptable, tolerant to alkaline soils and is effective in erosion control.

5. Heteropogon contortus (L) (Lampa ghas)

It is perennial, the culm erect to 75 cm, branching above leaf sheaths keeled, glabrous. Receme solitary, 3.5-1.5 cm long up to 10 pairs of awnless spikelets at baes and equal number of pairs above. Fertile sessile spikelets have 5-10 cm long awns. The grass is palatable in early stage but unattractive, as it’s mature. Beside fodder its main attributes are hardness, perennially, tolerance to fire and:ability to grow on poor soils.

6. Sehima nervosum (Willd) Stapf (Rats tail)

It is one of the most palatable grasses of the area and disappears quickly under grazing and used in haymaking. The species has densely tufted culms with leaf blades upto 30 cm. Recemes are solitary, 7-12 cm long, sessile spikelets pale green with long bristles from the upper glume and an awn about 45 mm long from the lemma, pedicel spikelet purplish.

Legumes

1. Atylosia scarabaeoides (Linn.) Benth (Chuha ghas)

It is a potential perennial pasture legume and is a climber forming thick mats, rootstocks. It is deep rooted and nodulated but nodules are few. Leaflets are elliptic, the lateral slightly oblique, 0.8-7.3 cm long. 0.5-3.0 cm wide rounded to subacute at both
ends. Inflorescence axillary, few flowered and peduncles 1.0-3.0 mm long. The protein contents ranged from 8.6 to 12.9 percent through out the year and averaged 1.6 percent calcium and 0.15 phosphorus levels. It occurs with S. nervosum but not with H. contortus.

2. Clitoria ternatea (Linn.) (Aparajita)

It is known as butter fly pea and native of tropical America, widely grown as an ornamental in the warmer part of the world. It is a climber, shrubby at base, 5-7 leaflets, and 3-5 cm long. Flowers are solitary, deep blue, occasionally pure white, very short pedicillate. Pods are flat, linear and beaked about 10 cm long. It is very palatable and its lack of persistence is often due to selective grazing by the animals. It is a drought resistance also asset. The percentage of crude protein ranged 13.5-19.5 percent.

3. Macroptilium atropurpureum (DC) Urb. (Siratro)

It is commonly known as Siratro and occurs naturally in central and South America. It has deep rooted with trailing pubescent stems. Leaves are pinnately trifoliate, dark green and slightly hairy on the upper. The inflorescence is a raceme, 6-12 flowers crowded at the apex. Siratro is palatable and livestock eat the runner’s back toward the crown, which should be protected, from over grazing. Siratro hay can be made only with difficulty because of the heavy lost by leaf drop. It is able to competes with weed and many grasses (Skerman et al., 1992).

4. Stylosanthes hamata (Linn.) (Carribean Stylo.)

S. hamata is an exotic important pasture legume for dry tropical environments. It has been used widely in pasture improvement programs in northern Australia. It is poorly adapted to regions with <760 mm annual rainfall and to cooler environment with >300 m altitude. Some of differences between S. hamata and S. scabra are potentially important for cattle productivity particular differences in digestibility and sodium (Na) concentration. It is also known as carribeen stylo and a herbaceous annual to short lived perennial, much branched, semi erect with a dichotomously branching. Leaves are trifoliate with long, narrow, shiny leaflets. It is more palatable and makes excellent hay so long as it is cut before leaf fall commences.

5. S. scabra (Linn.) (Shrubby Stylo.)

It is commonly called as shrubby stylo, talled upto 2 meter, perennial legume, erect to sub erect. The stem is woody usually densely hairy, making them dry condition
and colour of stem vary from pale green to dark blue green. Leaves are trifoliate, leaflets hairy on both surfaces. This species is very drought tolerant, root very deeply penetrating taproot. Once established *S. scabra* is very strong competitor able to persist with *C. ciliaris*. It is not used in hay or silage making due to hardness of stem or branches.

**Animal Component Study**

In the improved pasture land four grazing systems viz., rotational, deferred rotational, continuous and cut & carry will be imposed. Each grazing system, there will be 9 sheep, 9 goats and 3 cows for this study, therefore the total number of 36 sheep, 36 goats and 12 cows will be taken. All the animals will be maintained throughout the year only on grazing from July to October and from November onward a concentrate of mixture will be offered @ 0.75 % of the body weight in addition to grazing.

**Methods**

**Climatic Study**

The microclimate parameter viz., air temperature, relative humidity (RH) and rainfall were measured at fortnightly intervals on clear sky days. Air temperature was recorded through infrared thermometer while relative humidity (RH) was measured by using a dial type self-indicating hair hygrometer.

**Soil Study**

The soil samples were taken from two different depth viz., depth (0-15 cm) and (15-30 cm). The samples were taken by post-hole auger. Before taking samples vegetation was cleared from the land surface. For analysis, soil samples were air dried in shade; crushed with a wooden pestle and mortar and passed through a 2 mm (10 mesh) and leveled samples were packed in polythen bags.

The soil pH was estimated by using digital glass electrode pH meter at a ratio of 1:2 soil water suspension and soil moisture was determined by drying a known weight in a hot air oven at 105°C till constant weight. The soil texture was observed by Bauyoucos hydrometer method as prescribed by Piper (1966).
The available nutrients (NPK) were measured by different methods of soil analysis. Available nitrogen was determined adopting alkaline permagnate method (Piper 1966) and Olsen et al., (1954) method, determined available phosphorus. The available potassium was estimated by flame photometer. The estimation of organic carbon was done by Walkey and Black’s method.

**Plant Study**

**Pasture Improvement Method**

The area was fenced and divided into the paddocks (1.0 ha each) for grazing purpose and over number of nonpalatable and undesirable bushes were removed. Contour bunding was done for sloppy land with less than 6 % slope. The reseeding of suitable potential forage species (grasses and legumes) had done according to habitat and climatic condition. Grasses were *Cenchrus ciliaris, C. setigerus, Chrysopogon fulvus, Dichanthium annulatum* etc., while legumes were *Atylosia scarabaeoides, Clitoria ternatea, Macroptilium atropurpureum, Stylosanthes hamata and S. scabra*. All paddocks were improved through the seed mixture of grasses and legumes pasture. A single basal dose of fertilizer at @ 20 kg N/ha and 20 kg P₂O₅/ha was given to all 16 paddocks at sowing time and 20 kg N/ha was applied at top dress at 1.5-2.0 months sowing or establishment.

**Herbaceous Component**

Before introduction of grazing animals, botanical composition was studied through the line interception method and for this 20 transects (2 meter) were taken from each paddock and computing percentage relative composition, basal cover, frequency and Importance Value Index (IVI) were computed for all the constituent species. The vigour of 10 plants of prominent grasses and legumes were studied at the 50 % flowering from each plot. The productivity from herbaceous vegetation was determined in term of plant biomass. For plant biomass” Harvest method” was employed, for this Quadrat was used. Ten Quadrats (50x50 cm) were harvested from each paddock and this harvested material was sorted out into different species and species groups viz., perennial grasses, annual grasses, other grasses, legumes, forbs and litter.
Woody Component

The total numbers of individual of woody species were counted for percentage composition/density. Growth data were recorded in the month of May-June of year. The growth of woody vegetation was analyzed through different growth parameters viz., collar diameter and number of branches per plant. The collar diameter (cd) was measured at the base with the help of tree caliper. The numbers of branches were estimated as branch raised from main stem. For this study 10 percent of the total number of woody plants per hectare were studied of each species. The productivity of woody/shrub component was measured in term of fuel wood and top feed production in each paddock of each grazing system. Of which three plants of each species were selected (one large, one medium and one small size) and felled during the months of April-May in each year. After felling, the whole plant was kept under shade in cleaned area or tarpaulin. For top feed, leaves were separated and weighed. The main stem and other branches were kept under for sundry for about one month from the date of felling and weighed for determination of fuel wood production. The average value of three plants of each species was calculated to represent the fuel wood and top feed production.

Forage Quality

The chemical composition of pasture herbage was estimated for growth and post growth period. Forage samples were collected from each plot of each grazing system and was analyzed for chemical characters viz., dry matter (DM), crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL). Before analysis, samples were thoroughly washed successively and make moisture free by pressing the plants between filter papers. The plant samples then dried in a hot air oven maintained at 80°C and grinded. Finally grinded samples were estimated for crude protein as Kjeldahl method prescribed by A.O.A.C. (1988) and forage fibre contents (NDF, ADF, and ADL) were determined by method of Goering H.K. and Van soest P.J. (1970).
Animal Study

The grazing was started after establishment of pasture properly in the all paddocks and allowed @ 1.5 ACU (Adult Cow Unit) per hectare in a ratio of 1:1 of sheep & goats and cow. Thus in each grazing system all the animals were maintained through out the year. From July to November the animals were maintained only on grazing, there after from December to June they were offered with concentrate mixture @ 0.75 kg of body weight in addition to grazing. The body weight changes were recorded at fortnightly intervals in seasonally during growth and post growth period of vegetation.

Grazing methods

The following grazing systems were employed during study period. Each grazing system was grazed by 9 sheep+ 9 goat+ 3 cow.

1. Rotational

In this grazing system all the animals will be kept together and 7 days rotation will be followed in the four plots (4,6,11 &15).

2. Deferred rotational

In this system, out of four plots (3,5,9 &13) one plot was left ungrazed till maturity of pasture to allow seed formation and three plots were grazed following 7 days rotation but after seed dispersion deferred plot was also grazed following 7 days rotation.

3. Continuous

All the animals were allowed to graze simultaneously in four plots (2,7,10 &16) of 1.0 hectare each.

4. Cut & Carry

In this system the animals will be maintained primarily on the stall fed condition and forage will be harvested from their four plots (1,8,12 &14) and offered.