



GRASSES AND LEGUMES FOR TROPICAL PASTURES



Indian Grassland and Fodder Research Institute



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Published : October, 2002

Published by :
Director
Indian Grassland and Fodder Research Institute
Jhansi-284 003 India

Printed at :
Mini Printers
Jhansi
Ph. : 447831, 446820

Front Cover (Background)	:	Pasture developed in CPRs
Front Cover (Inset)	:	Pasture Legume - Stylo
Back Cover	:	1. Sehima nervosum 2. Iseilema laxum 3. Vetiveria zizanioides 4. Heteropogon contortus

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FOREWORD

Grasslands and pastures play an important role in the sustenance and development of animal husbandry, which is an indispensable part of Indian agriculture. But the main reasons for the poor performance of livestock in the country are inadequate supply of nutritious forage and feed on one hand and lower production potential of animals on the other. Therefore, the success of livestock industry depends upon feeding sufficient quantity of quality forage to productive animals. Thus, for achieving the goal, considerable efforts have been made at national level, to improve the herbage quantitatively and qualitatively by growing potential and improved grass/legume species on marginal, sub-marginal and degraded habitats.

Attempts made by Dr. B.K. Trivedi in compilation of important information on various range grasses and legumes are appreciable. I hope this bulletin will be useful to all those engaged in forage production, feed resource development and livestock management.

P. S. Pathak
Director

PREFACE

According to livestock census of 1992 the total livestock population is 470.9 million heads and this projected figure by the turn of century will reach to a value of 494 million heads. On the other hand total available feeds from all resources are 800 m.t. while the total feed/fodder requirement for existing livestock is 1350 m.t. To fulfill this large gap either we have to increase the land area already engaged for the purpose or search for the technology for higher forage production including promising varieties/cultivars of forage grasses and legumes. But due to human population pressure, the expansion of land for forage is not possible for solving the forage deficit second option is the only possible alternative.

In this field a considerable work has been done at Indian Grassland and Fodder Research Institute, Jhansi and also in other parts of the country. The information on package of practices of 31 range grasses and 20 range legumes is compiled on following heads for the ready reference of each species.

Botanical name, Synonyms, Common names, Description, Origin and distribution Climate Soils, Management schedule, Cultural practices, Seed rate, Seed treatment, Fertilizer application, Forage yield, Seed yield, Nutritive value, Utilization, Compatibility, Varieties/ cultivars.

In addition to this, the information on nursery raising has also been incorporated. It will be of immense value to forage researchers and development agencies as well as to livestock managers.

I express my deep sense of gratitude to Dr. P. S. Pathak, Director, Indian Grassland and Fodder Research Institute, Jhansi for his guidance and constant encouragement. I sincerely thank Dr. M.M. Roy, Principal Scientist and Head, Grassland & Silvopastures Management Division for help and providing the facilities for compiling the information. I am also thankful to Dr. K.C. Kanodia, and Dr. Vinod Shankar G.M. Division for extending their valuable help during the course of preparation Manuscript. I record my sincere thank to Dr. S.N. Tripathi and Dr. J.N. Gupta, Principal Scientists, IGFRI for critical suggestions and going through the manuscript. Last but not the least, I place on record the constant endeavor of publication committee for bringing out this bulletin.

B.K. Trivedi

INTRODUCTION

India is basically an agricultural country with more than 70 per cent of its total population living in the rural areas. The rural population is dependent mainly on agriculture and animal husbandry for their sustenance. India with about 2 per cent of the total world's geographical area sustains as much as 15 per cent of the total world's livestock population which plays an important role in country's rural economy and in meeting the demand for milk and milk products, meat, wool, hides and bone manures etc. In recent years the population growth of both human and livestock has created a tremendous pressure on our land resources. The area under agriculture has increased by 18.6 per cent and the livestock population by 61.2 per cent between 1951 and 1992 (Directorate of Eco. & Stat. 1992). The livestock population has been increasing continuously whereas the land under permanent pastures has shrunk. This has further complicated the situation. About 4.9% of total cultivable land (AICRPFC 1995) and culturable wasteland is put for fodder crops which is occupying nearly 101.0 m h. This is being utilized for growing forage grasses and legumes and so called grasslands and pastures.

There are various reasons for the enormous increase in the livestock population of the country. One of the reasons is social attitude of the people. In villages, maintaining a large number of cattle is considered as a status symbol, though they may be unproductive and uneconomical to maintain. Limited fodder resources of the country are unable to meet the requirement of ever increasing livestock population. Thus livestock is under fed. Moreover present land utilization in India does not permit any more good land to be put for fodder production. The solution to the problem lies in increasing the productivity of our grasslands, improving the degraded rangelands, manipulating the livestock population and adopting the principles of grazing management.

Grassland agriculture is a farming system that emphasizes the importance of grasses and legumes to the livestock and land management. The main feature of grassland agriculture is its dependence on herbaceous plants such as grasses, legumes and forbs and in many situations the leaves, buds, and stem tops of shrubs and woody vegetation.

Grass yields more starch equivalent and protein per acre than any other crops. Good grasslands, if effectively grazed, may have a starch equivalent of 66 per cent and a protein equivalent of 15 per cent. These pastures will produce 2000-3000 lb of total digestible nutrients (TDN) per acre. The out put of the best feeding pastures in terms of liveweight increase per acre per annum may be as high as 15 c wt. (or 900 lb per acre per annum of meat) when intensively farmed although a more usual figure for first class permanent pasture would be 3-3 1/2 cwt. liveweight increase (200-300 lb meat).

There are about 620 and 650 genera and 10000 and 18000 species of grasses (Poaceae) and legumes (Leguminosae) respectively in the world. Of these only about 40 grasses and legumes are used to appreciable extent in the establishment of sown pastures. Moreover, it has been found that livestock prefer indigenous forage species in comparison to selected varieties of grasses and legumes despite the fact that indigenous species may be low in productivity and nutritive value.

On the basis of following characters the grasses are considered suitable as forage plants for grazing or mowing.

1. Grasses (members of Gramineae/Poaceae) have wider range of adaptability than the species of any other family, being found in humid tropics, arid areas and alpine peaks.
2. Reproduction of fresh shoots by tillering provides a means of recovery from grazing or cutting.
3. Many grasses maintain continuous vegetative growth interrupted only by drought or cold.

4. Many grasses spread by rhizomes or stolons, which readily form adventitious roots and give rapid ground coverage.
5. New tissues produced during growth, arise chiefly at the base of the leaves where these are least to be damaged by cutting or grazing.
6. The root system binds the soil particles together forming a sod and brings to the surface layer nutrients, which have been leached into the sub soil by heavy rainfall.
7. In addition to above while selecting the species for pasture, the qualities desired are productivity, palatability, high nutritive value and adaptation of the species with local soil and climatic conditions.

ACRONYMS

E - English	O - Oriya
G - Gujrati	P - Punjabi
H - Hindi	S - Sanskrit
K - Kannada	T - Tamil
MI - Malyalam	Te - Telugu
Mr - Marathi	CP - Crude protein

TECHNIQUES FOR NURSERY RAISING

The seed is the prime material for establishing the grasslands /pastures. In forage species particularly grasses, the seed production varies from species to species. When seed becomes a limiting factor, seedlings/ rooted slips are the only alternate source for establishing the pasture. These seedlings are raised in nursery.

Establishment of Nursery

Nursery beds should carefully be prepared and cleaned from all rank growth including weeds by pulling out and burning. Generally the nursery is raised during May and for this 6m x 6m beds are common. The bed is thoroughly ploughed and 30 kg Farm Yard Manure, 0.250 kg urea, 0.5 kg Singly Super Phosphate and 50g BHC may be mixed thoroughly as a basal dose in each bed. The bed is watered for 4 to 6 days, so weeds would come up which are to be removed. About 2 g Bavistin is mixed with sun dried seeds. For proper sowing sand is mixed with seeds and then the seeds are sown 5-6 mm deep in line. The distance from line to line should be 10 cm. After sowing it may be covered with a thin layer of soil immediately and the bed may be mulched with straw/wet gunny bags or any locally available material for a period of 4-6 days continuously to allow the seed germination. Watering may be done twice a day at morning and evening with rose can. The germination starts from 3rd day and should be completed with in a week. After full germination mulch/gunny bags are removed. In places where day temperature is very high, it may be necessary to provide shade to seed beds in order to protect delicate seedlings The shade may be removed after 30 days of sowing but the beds are watered every alternate day with necessary weeding and hoeing.

Germination of dehusked seeds is recored as 94-98 per cent as compared to husked seeds, which is 35-42 percent. The stored seeds show better germination as compared to freshly collected. About 40-50 g of grass seeds are used for each bed. Such 12 beds are required to provide seedlings for a hectare land. For better growth of seedlings the crop should be top dressed with Calcium Ammonium Nitrate (10 kg N/ha). Grass seedlings will be ready for transplanting after 4 to 6 weeks when they attain 15 to 25 cm height.

Planting Technique

Seedlings/rooted slips are transplanted in well prepared field immediately after the onset of monsoon. Land preparation is done through desi plough, two to three ploughings are sufficient. Farm Yard manure @ 10-12 cartloads per hectare and BHC (10%) are mixed at the time of last ploughing.

The nursery beds are watered copiously before pulling out the seedlings. The seedlings are pulled out with ease and without damage to their root systems. Timely planting is necessary for good growth and yield. Two seedlings are transplanted per hull at a distance of 50 x 30cm between rows and plants respectivley. The soil, around the seedlings should be pressed gently to remove the air.

Through weeding and hoeing is essential during the initial year of establishment as the grass is unable to compete with other forbs, care should be taken to remove dried seedlings/ clumps and gap filling should be done immediately to maintain the optimum plant population.

Tropical forage species and their package of practices

Raising of grasses or pastures is an important activity. For this purpose, a set of cultivation practices is required on priority for the development of grasslands. Based on a large number of experiments, the practices evolved at IGFRl, Jhansi and elsewhere in the country are provided in

the following pages for the important tropical grasses and legumes. Out of a vast spectrum of grasses found in the world and nearly 3000 species in India, only a few have been selected, on the basis of fodder value, soil and water conservation purpose and perenniality for tropical and sub tropical regions of the country.

However, before dealing with the cultural practices of major perennial species, which play varying degree of fidelity among the population as well as with the habitat, it was felt essential to provide their important characters, so as to recognize these in the fields under different habitat conditions. An attempt is also made to provide their common and local names in different languages as well as notes on their origin, distribution, botanical description and habitat factors (climate and soils).

GRASSES

***Axonopus compressus* (Swartz) Beauv.**

Common names : Broad-leaf carpet grass, Savannah grass (E.)

Description : It is a glabrous, perennial, 25-75 cm high robust and stoloniferous plant. Leaves are 5-20 cm long and 9-12 mm wide with obtuse apex and form a dense mat over the surface of the ground. The inflorescence consists of two to three slender, sessile and erect spikes. The spikelets are 2.2-2.5 mm long. There are about 297000 numbers of seeds in one kg.

Distribution : It is native of South and Central America, West Indies and now distributed in Australia, India, tropical Africa, Indonesia and Philippines.

Climate : It is adapted to humid and sub-tropical conditions with an annual rainfall 1,140 mm or more.

Soils : It prefers moist, sandy or light textured soils of low fertility where moisture is available throughout the year.

Cultural practices : For pure pasture a well prepared field is required and surface sowing is

done @ 6 kg/ha during late summer. It also spreads more quickly by stolons and rhizomes under favourable conditions. Normally it does not require fertilizer.

Fertilizer application : This grass responds well to fertilizer and common dose of (30kg N + 20 Kg P₂O₅) is economic.

Forage yield : From a fertilized pasture (56 kg N/ha) about 51.9 t dry matter/ha was recorded.

Nutritive value : It is poor in nutritive value and during dry season 7.6 per cent C.P. was found in 8 weeks old forage crop while during wet season the C.P. was 11.4 per cent at same age.

Utilization : Due to low C.P. content and coarse in nature, it is less palatable and not fit for hay and silage. It provides good ground cover, therefore, it is used against the erosion for stabilizing the banks of dams. It is also used for lawn purposes.

Special Feature : It has an active nitrogenase system and over a period of 9-12 weeks, fixes 13 kg N/ha.

***Bothriochloa intermedia* (R.Br.) A. Cam**

Syn. *B. bladhii* (Retz.) S.T Blake.

Common names : Forest blue grass (E), Bada Phulwa, Fulkara (H)

Description : Perennial, tufted, erect, 2 m tall, 5-7 noded, nodes glabrous or upper bearded. Blade linear, 30 cm long tapering. Panicles narrow, 10-25 cm long. Racemes 12-38 mm long. Pedicelled spikelets.

Distribution : Pacific Island, N.E. Australia, Tropical Asia, China and Tropical Africa. In India distributed throughout tropical to sub-tropical parts from Punjab to West Bengal.

Climate : It is a grass of semi-arid regions and prefers 900 mm average annual rainfall.

Soil : It occurs mainly on heavy clay loam to clayey soils and heavier alluvial soils.

Cultural Practices : After proper land preparation the seed is broadcasted @ 4kg/ ha or seedlings/ rooted slips are transplanted at a distance of 50 cm from plant to plant and 75 cm from row to row preferably in a drizzly day. One or two weeding are required in the first year.

Fertilizer application : Recommended economic fertilizer dose is 120 kg N + 60 kg P₂O₅/ha.

Forage yield : In normal conditions the grass produces 2.4 t/ha dry matter and with the application of fertilizer the yield is 7.8 t/ha.

Nutritive value : It contains 6.0 per cent crude protein (CP) at flowering stage in natural condition.

Utilization : It provides good hay to animals.

***Bothriochloa pertusa* (L.) A. Camus**

Common names : Sour grass, Indian blue grass (E), Phulwa (H), Jirgi (Mr.), Chiana Karai (T), and Janu Gaddi (Te).

Description : Perennial, bunchy grass, 1 m tall, nodes bearded with spreading hairs, internodes smooth and shiny. Inflorescence purplish, aromatic, made up of a cluster of 3-8 spikes. Spikelets are in pair, one sessile and awned and the other pedicelled and awn less. The glume of the spikelets has one prominent pit. Seed count is about 12,10,000/kg.

Distribution : It is distributed in South east Asia and tropical Africa. In India it is found widely distributed in U.P. and other northern and southern states up to 2000 m altitude.

Climate : It prefers drier habitats in the rainfall zones ranging from 300 to 1200 mm in arid and semi arid climatic conditions.

Soils : It grows well on coarse sand to fine textured sandy loam to loamy soils.

Cultural practice : It can easily be established on poor soils with minimum tillage through broadcasting seeds @ 4 kg/ha.

Fertilizer : A common dose of 40 kg N + 25 kg P₂O₅/ha is recommended for higher forage yield.

Forage yield : Production potential of this grass is 44 t/ha with 73.0 per cent dry matter in October under zero fertilizer. Under rainfed and unmanured condition it provides good forage in two cuts at 60 days intervals i.e. end of July and September.

Nutritive value : C.P. value under zero fertilizer ranges from 7.1 to 2.4 per cent in July and November respectively.

Utilization : It is utilized mainly for forage purposes.

***Brachiaria brizantha* (Hochst ex A. Rich) Stapf**

Common names : Congo signal grass, Palisade grass, Ceylon sheep grass (E).

Description: It is tufted, semi-erect, spreading, 1.20 m high, drought-resistant and perennial grass. Leaves are deep green. The seeds remain viable for about 3 years.

Distribution : It is an exotic grass, originally belongs to East Africa and was introduced in India in 1950 from Australia. In India it is found in coastal regions.

Climate : It requires warm and humid climate.

Soils : This grass thrives well on loamy soils.

Cultural Practices : In a well prepared, fertilized and level land small rooted slips with 2-3 nodes are transplanted. The pasture can also be established by direct seedlings in lines at 30 cms apart at the onset of monsoon season in dryland

conditions and any time in the irrigated conditions as well as in heavy rainfall regions.

Management schedule : It can be heavily grazed if used as a monospecific sward and regularly fertilized with nitrogen. If grown with legumes, the grazing system must favour the legume and adequate phosphorus must be maintained.

Fertilizer application & forage Yield : It responds well to fertilizer application and yielded 3.0, 4.0 and 120 t/ha under control, 60 kg N and 120 kg N/ha respectively in two cuts.

Nutritive value : It is used for hay making for lean period. It contains 9.6 and 8.1 per cent C.P. in July and October respectively.

Utilization : The grass remains green for major part of the year even under the rainfed conditions. It is much relished and is quite palatable.

***Brachiaria mutica* (Forsk.) Stapf**

Common names : Para grass, Buffalo grass, Water grass (E) Pani Wali ghas (H).

Description: It is an exotic, hairy and perennial grass, spreading rapidly by surface runners, profusely rooting at nodes. Stems rhizomatous with ascending branches; culms hollow, succulent and glabrous with hairy inter-nodes. Leaf blade linear, dark green, 30 cm long and 6-16 mm broad. Inflorescence is open panicle and 6-20 cm long. Seeds count about 10,00,000/kg.

Distribution : It is native to Brazil and was introduced to India in 1894 at Poona. It grows well in water logging conditions on river and canal banks.

Climate : It is a grass of tropical climate and grows well in warm humid situations climate of high rainfall areas but in protected areas it can persist with rainfall as low as 900 mm per year.

Soils : It performs well in clayey/silty/peaty/sewage farm soils.

Cultural practices : In a well prepared and levelled field, shoot bits of 30 cm length each with 2-3 nodes are planted in lines at about 60 cm distance; under irrigated conditions best time of planting is in March while under rainfed conditions at the onset of monsoon.

In the early stage of establishment, the grass sends out surface runners, which root at

nodes and erect shoots are produced and thus whole field is covered with surface runners. The first cutting is therefore delayed.

Fertilizer application : A basal dose of 5 tonnes of FYM/compost followed by a top dressing of 90 kg N/ha, through Ammonium sulphate or Diammonium phosphate after every 2-3 cuttings which ensures higher fodder production.

Management schedule : It should not be grazed too closely and first grazing should be deferred till the grass is 30-60 cm high and well established. Controlled/ light grazing ensures rapid growth.

Forage yield : Generally para grass is ready for the first cut in 3 months from planting and subsequent cuts are possible at monthly intervals. The green forage production ranges from 1950 to 2755 t/ha.

Nutritive value : The grass is less nutritive with 7 per cent C.P., 0.76 Ca and 0.49 per cent phosphorus.

Utilization : The grass is used as green fodder, soiling and even for hay. It can withstand moderate grazing. It is highly profitable to grow on submerged or low lying as well as saline soils where nothing else survives.

Compatibility : The grass performs well with legumes like *Centrosema*, *Calpogonium*, *Lotononis* sp., *Vicia* and *Aeschynomane*

***Cenchrus ciliaris* Linn.**

Common names : Buffel, African foxtail grass (E), Anjan (H), Pillu and Koluka Hai (T) and Kusa (Te).

Description : Perennial, tufted, 0.3-1.2 m tall. Leaf blade linear, 2.8 to 24.0 cm long and 2.2 to 8.5 mm wide. Inflorescence dense, cylindrical, 2.0 to 12.0 cm long. Seed count 4,50,000 to 7,03,000/kg. Seeds remain viable for 2 to 3 years.

Distribution : The Buffel grass is an inhabitant of dry sandy areas throughout Africa,

Madagascar and eastwards to Burma and Ceylon. In India it is a natural species largely found in Rajasthan, Haryana, Punjab, Gujarat and parts of western U.P. and Tamil Nadu state.

Climate : It grows well in rainfall zones ranging between 125 to 1250 mm in arid and semi-arid regions of the country. It can withstand drought and can also grow very well under irrigation.

Soils : It comes up best on well drained, light to medium textured soils which is red in colour and calcareous in nature. Its establishment on

heavier soils (clay or lateritic) is not successful especially on soils deficient in lime.

Cultural practices : In well levelled land the sowing is to be done in lines using 4 or 5 kg seeds/ha after first shower in monsoon. Six weeks old seedlings/rooted slips can also be transplanted in a drizzly day at 50 cm row spacing and 30 cm plant to plant. Thus about 33,000 seedlings or rooted slips are required for one hectare area with 2 seedlings at each spot. But for undulating area the seeds are to be broadcasted at a bit higher rate before monsoon. In all these sowing is done at very shallow depth i.e. 0.5 to 1.0 cm. After sowing, a small twig of a tree is dragged over the land to cover the seeds with a thin film of soil. One weeding in the form of interculturing is helpful for better crop.

Fertilizer : In the first year a basal application of 5 tones of Farm Yard Manure (FYM) alongwith 40 kg N and 20 kg P₂O₅/ha is to be mixed thoroughly in the soil at land preparation. Afterwards 20 kg N/ha is topdressed at one month crop stage. However in subsequent years 40 kg N + 20 kg P₂O₅/ha needs to be top dressed as a single dose at the onset of monsoon. For higher tonnage another dose of 20 kg N/ha may be applied after the first harvest.

Management Schedule : In the first year of establishment only one cut is to be taken in mid October. From first year onward this grass gives 3-4 cuts and more can be had if irrigation is available. The first cutting should be taken at 60 days interval and subsequent cuttings after 30-45 days intervals depending on the rainfall. Cutting height may be kept 5-10 cm from ground level to ensure good regrowth in following years.

The pasture is more productive during 2nd to 4th year, afterwards for its sustained production the pasture should be burnt moderately or ploughed.

Forage yield : Depending on rainfall the yield varies greatly and in arid tract with less than 300 mm rainfall a well established pasture produces 9.0 to 11.0 t/ha green matter while in semi-arid tract of 950 mm rainfall, the dry matter yield ranged from 6.0 to 11.4 t/ha.

Seed yield : For seed production 75 cm spacing is advocated from line to line in order to avoid over crowding through self seeding. A well established pasture yields around 125 kg seeds/ha.

Grass-legume mixture : For quality forage after every two rows of grass spaced at 50 cm, one row of legume viz., Siratro or Caribbean stylo could be planted. For this, the legumes to be sown first at 1.5 m interval and then the grass seedlings are transplanted after the legumes have germinated. Such practice minimises the competition between the legume and grass seedlings for establishment and growth.

Nutritive value : The grass is relished by all classes of livestock. It contains 11.0 per cent C.P. at young stage with suitable ratio of Ca and P.

Utilization : The grass is mostly used as cut and carry fodder but also well suited to grazing. This provides very good hay since it retains its nutritive value even when ripe fully. For silage the grass should be harvested at flowering or seeding stage. Cultivars, S-262 and S-358 are found suitable for soil conservation purposes also.

Varieties : Mallapo, Buffel, IGFRI No.3108, 3132, CAZRI-358, Marwar Anjan (75).

***Cenchrus setigerus* Vahl**

Common names : Bird wood grass (E), Dhaman (H), Black Kolukattai (T).

Description : Perennial, forming culms from bulbous base, 0.2 to 0.9 m tall, leaf blade 2 to 20 cm long and 1.8 to 6.9 mm wide. Inflorescence compact, spike 2 to 20 cm. long, 0.4 to 1.0 cm wide. The root system is generally

less developed than *C. ciliaris*. Seed count 3,50,000/kg.

Distribution : It occurs throughout hotter parts of Africa, Arabia and India. It is also found in Australia and South America and introduced as an experimental forage grass in many parts of the country. In Indian sub-continent it is

naturalised in Sindh, Punjab, Rajasthan, Haryana, Gujarat and other warm regions of North-West India.

Climate : Arid and semi-arid conditions are favourable with 125 to 1250 mm rainfall. It withstands drought and grows very well under irrigation.

Soils : It grows well on well drained sandy-loam soils with pH ranging from 7 to 7.5.

Cultural practices : Land is to be well ploughed after removal of all rank vegetation. The seeds are sown in line at a row spacing of 50 cm using 10 kg seeds/ha.

Fertilizer application : At the time of land preparation 10 cart load of FYM is thoroughly mixed in soil alongwith 30 kg N + 30 kg P₂O₅/

ha. Afterwards 30 kg N/ha is given as top dressing at the age of one month crop. In subsequent years prescribed dose is repeated at the onset of monsoon.

Forage yield : The dry forage yield of species varied from 3.9 to 7.9 t/ha in unfertilized and fertilized (90 kg N/ha) plot respectively under rainfed conditions. Pusa yellow Anjan produced maximum forage (6.8 t/ha) yield.

Nutritive value : In this species 7.8 per cent C.P. was found in first cut.

Utilization : It is highly palatable grass for cattle and used as hay also. It can be grazed heavily.

Varieties : The recommended varieties are Marwar Dhaman (CAZRI-76) 296, Pusa yellow - Anjan, 175 and 415.

***Chloris gayana* Kunth**

Common name : Rhodes grass (E)

Description : It is fine stemmed, leafy, perennial, erect, rhizomatous or spreading, stoloniferous grass. Culms are 0.6 to 1.2 m tall with long and stout internodes. Leaf blades are 15-30 cm long and 3-5 mm wide, tapering to fine pointed tips. Inflorescence is spreading with 10-15 cm long, spikelets crowded, straw coloured on ripening. It produces profuse amount of seeds. Seed count 7250000 to 9500000/kg.

Distribution : It is a native of South Africa and was named after the famous Cecil Rhodes, who popularised it. The species was introduced in India through USA and later on in Karnataka in 1920. Being drought resistant it is found in semi-arid parts of the country and low lying areas.

Climate: It grows well in warm-moist conditions.

Soils : It prefers loamy to sandy loams and can grow even on a fair degree of salinity but can not withstand stiff clayey or waterlogging conditions.

Cultural practices : It can be established by seeds as well as by rooted slips. The establishment by seed is cheaper and for this a firm seed bed is prepared on well ploughed land

and seeds are broadcast @ 5 kg/ha at the onset of monsoon by mixing the moist soil. In high rainfall zones or under irrigated condition higher seed rate (10 kg/ha) is recommended or rooted slips can be transplanted in the lines at a distance of 50x50 cms for which nearly 40000 slips are required for one hectare. 1-2 interculturing and gap filling are required in the first year to ensure good establishment.

Fertilizer application : Since this grass responds well to manuring, 10-15 tonnes of FYM or compost alongwith 30 kg P₂O₅/ha as basal dose followed by 20 kg N/ha as top dressing for ensuring sustained productivity. In case of irrigated crop, irrigation after every 2-3 weeks alongwith 20 kg N/ha increases the forage production.

Forage yield : In pastures raised through seeds, first clipping can be taken after 3 months, while that from rooted slips after 2 months and subsequently after every month in both types of pastures. Thus, nearly 6 cuttings with an average yield of about 17.0 t/ha (green) are possible under rainfed conditions but under irrigation the yield is as high as 175.6 t/ha.

Seed yield : The seeds of this grass mature

after monsoon and are collected in October-November. The well fertilized pasture produces 100 kg seeds in one hectare.

Nutritive value : At preflowering stage C.P. is nearly 5 per cent with a balanced content of Ca (0.5 per cent) and P (0.3 per cent).

Utilization : The grass is suitable for pasturage,

silage and hay but it is generally used for soiling. Even after severe trampling it provides grazing upto September and could be utilized for hay thereafter.

Compatibility : It grows well with *Stylosanthes guianensis* and *Neonotonia wightii* and consequently 20 and 100 per cent increase in forage yield was recorded respectively.

***Chrysopogon fulvus* (Spreng) Choiv**

Common names : Dhwalu (H), Gusia (G), Pandhri Kusal (Mr) and Kare hull (K).

Description : It is highly variable, tufted, perennial and 1.8 m tall grass. Culms are slender and glabrous. Leaves are 25-30 cm long. Upper leaves are short (7.5 to 10 cm). Panicles are 3-13 cm long with several whorls of flexyous branches, with groups of 3 spikelets at their apexes. Out of these 3 spikelets one is sessile, bisexual, awned and other two are awnless and pedicelled.

Distribution : It is found in Asia and East Africa and throughout India especially in hilly areas upto 1830 m altitude in the gravelly land of Aravalli hills in Rajasthan, Central Plateau as well as lower ranges of Himalaya.

Climate : It is found in arid to semi-arid regions with 250 to 850 mm rainfall.

Soils : It thrives well on eroded, shallow and gravelly/stony soils of medium texture.

Cultural practices : Its habitat being stony or gravelly with shallow soils, ploughing of any sort is not advisable. Spot sowing/planting on sloppy lands and broadcasting of seeds in fairly plain areas, as well as transplanting of rooted slips during drizzly days of monsoon, have given best establishment of pasture.

Fertilizer application : About 60 kg N/ha has been found the most economical dose for higher forage production and for getting maximum seed, 40 kg P₂O₅/ha is beneficial in addition to above nitrogen dose.

Forage yield : In first year it gives only one cut but in subsequent years even 3 cuts are possible and the dry forage yield is 4.2 t/ha. Fertilized pasture produces about 10.0 t/ha forage.

Seed yield : The seed yield is upto 100 kg/ha.

Nutritive value : It contains about 4.6 to 5.1 per cent C.P. during the growth period (Aug.-Sept.). Cutting frequency (10 days interval) and use of N fertilizer (60 kg N/ha) increased the C.P. from 5.4 to 12.6 per cent. However, the C.P. decreased with the age of plant.

Utilization : If it is cut before flowering the grass makes good green fodder or may be grazed directly from 2nd year onwards upto 6th year. However, the grass is quite suitable for hay. It is a good soil binder also.

Varieties : There are two varieties of *C. fulvus* i.e. (i) Mhow and (ii) Chandigarh. The first one is taller and yields higher tonnage of forage while the later is more nutritive and grows luxuriantly during summer months even on sloppy lands when other grasses are totally dry.

***Coix lacryma-jobi* Linn**

Common names : Job's tears (E), Kahado (G)

Description : It is an annual/perennial 1-2 m tall and leafy grass. Stem is erect, stout with brace-roots from the lower nodes. Leaves are

10-45 cm long and 3-5 cm wide with cordate base and smooth sheath. Ligules are very short. Inflorescence is prolific with monoecious flowers; the first glume of the male spikelet narrowly

winged. The seeds are yellow, purple, white or brown.

Distribution : It is native to tropical Asia but now widely distributed in the tropics i.e. Africa and America. In India it is abundantly found in hotter and swampy parts especially in North-eastern Hill regions.

Climate : It is a species of humid climate and requires high annual rainfall in excess of 1500 mm.

Soils : It grows in swampy places near streams and requires fertile soils for best growth.

Cultural practices : It prefers well prepared field. The crop is raised by direct seed sowing (dibbling or broadcast) at a depth of 5 cm in rainy season with a spacing of 40-60 cm between plant to plant and 75-100 cm from row to row. Seed rate is 10-15 kg/ha. For seed setting it requires sufficient rains in the early stage of growth and dry period. Coix is hardy and remarkably free from diseases and insects pests. It is a crop of 140-160 days.

Fertilizer application : Job's tears gives good response with the liberal application of organic manures. Application of inorganic fertilizers is recommended after the analysis of soil in respect of nutrients status.

Forage and seed yield : Its average green forage yield is about 13.9 t/ha. Normally the seed production is 1500 kg/ha.

Nutritive value : Green material contains about 29.9 per cent dry matter, 8.5 per cent C.P., 27.9 per cent crude fiber and 8.9 per cent ash. The husked grain gave 10.8 per cent moisture, 13.6 per cent protein, 61 per cent fat, 58.5 per cent carbohydrate, 8.4 per cent fiber and 2.6 per cent ash.

Utilization : The green material is very palatable and is utilized as food and fodder both. The foliage may be used as fodder for cattle and can be turned into ensilage. It is also used for preparing the light beer. The seeds are used in medicines and also as livestock feed. The bran may be used as substitute for wheat bran in feeding the poultry.

Cynodon dactylon (L.) Pers

Common names : Bermuda, Lawn, Behama, Wire and Devil grass (E), Doob and Hariyali (H), Durba (S), Arugam pillu (T), Garicha gaddi (Te), Gasika hull (K) and Darodi (G).

Description : It is a profusely much branched, leafy perennial stoloniferous with a large number of runners. Each stolon when cut is capable of becoming a separate plant, hence easiest and earliest in establishment. Culms are highly variable in length. Leaves are short and soft. Spikes are 2-8 in number and 2-5 cms long, digitally arranged on the tip of erect peduncles. Spikelets are one flowered and awnless. Fruit is caryopsis. Seed count 4489000/kg.

Distribution : Doob is native to India. It was introduced from Behama Island in other countries like United States, and therefore it is also known as Behama grass. It is found in almost all the tropical and subtropical countries of the world from sea level to 2,130 m elevation.

Climate : It grows well in semi-arid conditions between 300-2000 mm rainfall but does not survive in low rainfall areas.

Soils : This grass thrives best on heavier silt and clayey soils not subjected to waterlogging or flooding. Sandy soil also does not suit to this grass. It is resistant to a great extent to drought and tolerant to salinity and alkalinity.

Cultural practices : After proper land preparation by 2-3 ploughing, the best establishment of this grass can be achieved through planting of cut pieces of stolons with 2-3 rooting nodes (runners) during monsoon season at 30-50 cm distance. After planting the field needs to be pressed by a light roller or feet. Establishment through seeds is not very successful, because the seeds are very minute and their germination is very slow. Moreover by the time small seedlings emerge from seeds they are smothered by other weed species.

However as an irrigated crop it can be established any time in the south and after March in North India. In sandy soils the rooted slips are to be planted 10 to 13 cm deep in rows, taking care to leave their tips above the ground.

Fertilizer application : This grass gives linear response to N-fertilizer and to increase the forage production 120 kg N/ha may be given.

Forage yield : Generally grass is ready for first cut in 3-4 months after planting and for subsequent cuttings after every two months interval and thus 4-5 cuttings may be taken every year. The average green forage yield ranges from 15.0-16.0 t/ha (4.0-5.0 t/ha dry matter) under rainfed conditions. However under irrigated conditions with 120 kg N/ha in 2-3

cuttings 30.0-35.0 t/ha green fodder (90-110 t/ha dry matter) can be harvested. To ensure best results of grazing; pasture should be augmented by growing a legume like *Calopogonium mucunoides*.

Nutritive value : It contains 11.1 per cent C.P. in young stage and about 7.0 per cent at maturity and least crude fiber (18.6 to 28.2 per cent).

Utilization : Being most nutritive, the grass is readily eaten by all types of livestock. It is used as green fodder or may be converted into excellent hay or grazed *in situ*. In addition to this, it is extensively used for checking soil erosion, gully plugging on check dams, embankments of rivers, canals and other sloppy stabilization programmes of reservoirs etc.

***Dichanthium annulatum* (Forsk) Stapf**

Common names : Marvel grass (E), Kail, Kared and Apang (H), Chhijhavo (G)

Description : It is an erect tufted, fine stemmed, perennial grass and 1.2 m tall. Culms are purplish red or bluish in colour, distinct rings of whitish hairs at each node. Leaves are green to bluish green, 23-45 cm long. Inflorescence is a compound raceme, made of a cluster (2-8) of purplish false spikes, arising nearly from the terminal tip of the culms. Each false spike is a raceme of paired spikelets, one sessile and the other pedicelled. Most distinguishing character of its spikelets is the absence of pits on the glumes.

Distribution : Naturally it occurs in Burma, Africa and Australia. It grows on the plains and upto 900 m on hills in India except in northern mountains.

Climate : It grows well in the areas of 350 to 2000 mm rainfall of arid and semi-arid regions.

Soils : It can grow on a wide range of soils but moist, well drained, medium black or red alluvial soils are preferred. It can tolerate a fair degree

of drought as well as salinity but does not thrive on acidic soils.

Cultural practices : In well leveled land the sowing is to be done in lines using 4-6 kg seed/ha after first shower in monsoon. But established pastures gave best results for which 5 weeks old seedlings/rooted slips can also be transplanted in a drizzly day at 50 cm row spacing and 30 cm plant to plant. One or two interculturing operations, depending on weed infestations are essential during first year for high tonnage.

Fertilizer application : At first, ten cartloads of FYM is given in 1 ha land. This is followed by basal application of 20 kg N/ha (preferably 100-kg calcium ammonium nitrate) and 20 kg P₂O₅/ha (i.e. 125 kg SSP). Afterwards 20 kg N/ha is required after one month crop through top dressing. However, in subsequent years 20 kg N + 20 kg P₂O₅ per hectare needs to be top dressed as a single dose at the onset of monsoon.

Forage yield : In first year it should be harvested once after seed shedding while in subsequent years 3-4 cuttings can be taken at

an interval of 60 days and 15 cm cutting height for quality forage. This grass gives high yield even under rainfed condition and dry matter yield ranges from 2.8 to 4.5 t/ha in single cut while 300 t/ha green fodder is recorded in 3 cuts. It can give 3 times more forage under irrigation.

Nutritive value : Its crude protein content varies from 5 to 7 per cent.

Utilization : Even having low C.P. the species is considered as one of the best grass for forage and is utilized as hay as well as for

grazing purpose. This is also good for soil conservation.

Compatibility : Siratro or stylos are the appropriate legumes and may be maintained in 2:1 ratio i.e. two rows of grass and one row of legume. For this the legume should be sown first in prepared land at a distance of 1.5 m and grass seedlings may be transplanted after the germination of legume species.

Varieties : IGFR1 495-1 and Marvel-8, CAZRI-490 and 485.

***Digitaria decumbens* Stent**

Common names : Pangloa grass, Digit grass (E)

Description : Pangloa grass is of creeping habit. It is densely tufted, branched and stoloniferous. It gives the roots from lower nodes. It grows to a height of 0.6-1.2 m. The spikelets are 2.5-3 mm long, glabrous. It does not produce viable seeds.

Distribution : It is originated in Transvaal and now distributed in most of the tropical countries e.g. Australia, India etc.

Climate : Humid coastal climate with 7-26 °C temperature and annual rainfall in excess to 1,015 mm favours the grass for higher growth.

Soils : It is adaptable to wide range of soils from extremely poor sands to heavy clays of low fertility.

Cultural practices : This species is mainly propagated vegetatively and establishes easily from stem pieces containing a few nodes. For its establishment, freshly mowed stem pieces with nodes and stolons are spread over a well prepared field and then these are covered with a medium weight disc harrow. One meter distance is maintained from one piece to another. All this is done during rainy season when adequate moisture is available in soil. About 500 to 2000 kg planting materials is required for 1 hectare area.

Fertilizer application : Generally 50-60 kg N/ha is applied for better results.

Management schedule : Its first cutting should be taken after three and half months from establishment and subsequent cuttings at an interval of 7-8 weeks. Rotational grazing with one week rest during growth period and 2 to 3 weeks rest in summer period is recommended for higher quality forage.

Forage yield : It produces 7.0-13.0 t/ha green forage. Sometimes it out yielded *Panicum maximum* cv. Hamil and *Brachiaria ruziziensis*, but yielded less than *B. decumbens* and *B. mutica*.

Nutritive value : Its analysis at floral stage revealed 11.8 per cent C.P., 30.2 per cent crude fiber and 9.2 per cent ash.

Utilization : At young and vigorous stage it is most palatable and is used for hay, silage and grazing purposes but it is usually neglected in comparison to other grasses when it becomes old and stemmy. It is successfully grown for controlling the erosion through water and wind both.

Compatibility : Under suitable conditions for its own development, pangola grass dominates all other species. It combines well with the legume *Lotononis bainesii* as both stand for heavy grazing. It can also grow with *Centrosema*, Stylo and Siratro.

Diplachne fusca (Linn.) P. Beauv

Common names : Karnal grass, Brown beetle grass (E), Dhaner, Choti gendar and Harri (H) and Nandi pillu (T).

Description : It is a perennial, tuft and erect grass growing 0.9 to 1.5 m tall. Culms are hollow and roots come upwards from lower nodes. Leaves are 45 cm long and linear. Panicles are 10-30 cm long and margins of lemmas and paleas are hairy. It is a relatively succulent and palatable grass.

Distribution : It is distributed in upper Gangetic plains, Bengal, Orissa, A.P., Madras and Kerala along coasts.

Climate : It grows successfully in tropical and sub-tropical areas. It prefers hot and dry season and even continuous submerged conditions. High humidity and wet soil moisture conditions are also favourable for its growth. It occurs in 300-450 mm rainfall regions and upto 1000 mm or more in coastal areas.

Soils : It gives good growth in alkali and saline soils.

Cultural practices : One deep tractor ploughing should be followed by 2-3 ploughings with country plough. In case of tractor one ploughing with mould board plough followed by two disc harrowings are sufficient. Sowing/planting (rooted slips or stem cuttings with 3 nodes) should be performed a few days prior to or with the onset of monsoon so that germination is ensured. Under irrigated condition it can be planted any time during summer but mid-June to mid-July is the optimum time for its planting. Row to row and plant to plant distance of 25 and 20 cm should be maintained respectively. One irrigation is essential, immediately after

the planting.

Fertilizer application : Karnal grass grows well even without fertilizer. To obtain higher yield and to maintain nutrition and palatability of the grass 20 kg N/ha is recommended after each cut. Since, alkali soils are rich in available phosphorus and potassium, these are not recommended. These soils are generally deficient in zinc, therefore if organic manure has not been added, zinc sulphate @ 25 kg/ha in first year might be beneficial for the growth of grass.

Management schedule : When planted in the month of July, 2-3 cuts can be obtained upto November in first year. While under good management (fertilized and irrigated) 5 to 8 cuttings may be taken from 1st year onwards. It is recommended that the grass should be cut at 5 cm height from ground level. In the monsoon the grass may be harvested at an interval of 25 to 30 days while in other months at an interval of 30 to 45 days.

Forage yield : In highly alkali soil this grass gives 30 to 40 tones green forage in one hectare without fertilizer but with the application of recommended dose of fertilizer the green forage yield reaches upto 60 t/ha. The yield levels are generally higher in rainy season than others.

Nutritive value : The nutritive value of the grass is quite satisfactory and it contains 8.5 per cent C.P.

Utilization : Animals relish this grass in young stage but compared with other fodder crops, it is less palatable. Alkali soils are reclaimed generally by growing the Karnal grass.

Eragrostis curvula (Schvad.) Nees

Common names : Weeping love grass, African love grass (E).

Description : It is densely tufted perennial grass of 0.9-1.2 m high. Leaves are rigid and long with pointed apex. Panicle is 20-30 cm long, green

or dark gray. Each spike has 7-11 spikelets, which are 7 to 10 mm long, and 2 mm wide. Seed count 38,50,000/kg.

Distribution : It is native to India and Tanzania and now distributed in South Africa and in most

of warm countries.

Climate : It prefers mild climate and 500-1000 mm annual rainfall.

Soils : It thrives well in sandy loam but may be grown in wide range of soils even in slightly alkali soils with 7.0 to 8.5 pH.

Cultural practices : It also requires a well prepared field where the seeds may be sown through broadcast (1 kg/ha) or drilled (0.5 kg/ha) in 1 m rows in late spring to late summer at 0.5-1 cm depth.

This may also be established through rooted slips.

Fertilizer application : It grows on poor soils

but for higher production it needs 40 kg N/ha.

Forage yield : Without any fertilizer its forage production is 2.1 t/ha but on adding nitrogen it yielded 8.3 t/ha. Under good management it produces 20.0 to 30.0 t/ha green forage.

Seed yield : Seed yield is 30-225 kg/ha under good condition.

Nutritive value : It contains 5.2 per cent C.P., 36.4 per cent fiber and 1.7 per cent ash.

Utilization : At young stage it is palatable and is used for grazing as well as for hay purpose. It possesses a good soil binding capacity and is utilized for checking the soil erosion on dams and other sites.

***Eulaliopsis binata* (Retz) Hubbard**

Common names : Sabai grass (E), Bhabar, Baib, Babui (H), Bubai (O).

Description : A tufted perennial grass, 0.5-1.5 m high with erect slender culms, shiny and woody at the base. Leaves are narrow, linear, 30-40 cm long. Inflorescence of 2-4 racemes, 3-6 cm long on piliform peduncles. Seed black, exceedingly minute and light. The seeds are collected during last week of December or 1st week of January.

Distribution : It is distributed throughout India and is particularly abundant on dry base slopes and forest banks of sub-Himalayan areas. It is common in Bihar Orissa, Bengal, Central India and Punjab.

Climate : It is hardy to frost and drought and requires 750-1500 mm annual rainfall. It prefers hot and dry climate.

Soils : It thrives best on well drained sandy loams and can grow even on poor soils not subjected to waterlogging.

Cultural practices : Sabai grass is best propagated vegetatively by division of root stocks and about 12-15 q rooted slips or 3 kg seeds are sufficient for 1 ha. In case of insufficient supply or non availability of rootstocks nursery beds are raised and 3 months old seedlings are transplanted in a well

prepared field with a spacing of 30x30 cm during a break in the monsoon. Thorough weeding is essential. Newly established pasture goes well for seven years and afterwards it should be re-established.

Fertilizer application : A recommended basal dose of 30 kg N + 20 kg P₂O₅ /ha might be useful.

Management schedule : Plantations raised from rooted slips begin to yield from the first year onwards. This is harvested annually during November-December but under good management 2 cuttings may be taken i.e. first in August-September and the second in November-December. The grass flowers during cold weather and for the purpose of paper manufacture the grass is cut prior to or during the flowering stage.

Forage and seed yield : The yield of the grass varies from 20.0 to 75.0 t/ha according to locality, rainfall and management. Seed yield is 25-40 kg/ha.

Nutritive value : It contains 2-3 per cent C.P., 32.1 per cent crude fiber and 6.4 per cent total ash.

Utilization: Being less palatable, it is used mainly in industries for making paper and straw boards. It is also used for soil conservation.

Heteropogon contortus (Linn.) P. Beauv. ex R. & S.

Common names : Spear grass, Tangle head (E), Lampa, parwa (H), Orsi Pillu (T), Paretu Mullu gaddi (Te), Sankari hull (K), Sukli (G).

Description : It is densely tufted, perennial and highly palatable, 0.9 to 1.0 m tall, erect or decumbent grass. It is leafy mainly at base. Leaves are firm, linear upto 60 cm long and 3.7 mm broad, often hairy with bulbous base. Racemes are terminal, erect, 4.8 cm long with prominent dark brown awns (3-12 cm long) which are jointly twisted together to form a bundle at maturity. Sessile spikelet 7 mm long, hidden by the pedicelled spikelets.

Distribution : It is found all over the world in Tropics and subtropics. It is indigenous to India and occurs in all arid and semi-arid regions and upto an elevation of 2000 m from North Himalaya to Cape Camorin and in the grasslands of east to west and whole of the south. In drier areas it dominates even by suppressing other grasses especially on poor and rocky soil.

Climate : It grows well in arid and semi-arid conditions in the rainfall zones ranging from 180 to 1200 mm.

Soils : It is highly variable and adaptable to all types of soils ranging from pure gravelly sand to sandy loam.

Cultural practices : Being hardy it does not require well prepared land and even comes in the land once ploughed. The seeds are broadcasted @ 5.0 kg/ha just before the monsoon. Interculturing is also not required.

Fertilizer application : Application of 60 kg N/ha as basal dose increases its productivity.

Forage and seed yield : In first year only one cut should be taken but from 2nd year onward it should be harvested at 30 days intervals and thus 3-4 cuts in a year may be taken under rainfed situation. Under semi-arid conditions with the application of 60 kg N/ha about 6.4 t/ha dry forage and 70 kg seed/ha may be obtained. This forage production increases significantly with the increase of N-fertilizer.

Nutritive value : At early stage it is a highly nutritive grass and even 10 per cent C.P. is found in July which decreases regularly and only 3 per cent is found in December on dry weight basis. Ca and P content of the species are 1.14 and 0.19 per cent respectively.

Utilization : It is very good fodder grass but due to presence of sharp awns or spears at maturity it is grazed accordingly to its carrying capacity or may be cut at pre-flowering stage for hay or silage. It is also used in soil conservation programme. Light burning is beneficial to the species.

Iseilema laxum Hack

Common names : Musiyal, Machhauri (H), Tengainer pul (T), Yera chengali (Te), Gandwal, Gandil (Mr)

Description : It is short, erect to decumbent or some what spreading tufted perennial grass with stout short, creeping rootstock. Stems are slender branched upto 0.97 m high. Base diameter of tussock is about 7.5 cm. Leaf blade is linear, obtuse, glabrous, ciliate near the base, 5 to 15 cm long. Inflorescence is narrow long panicle with a group of spikelets seated on the panicles in a boat shaped bract.

Distribution : It is distributed in Ceylon, Mauritius. In India it occurs throughout tropical part in moist areas from sea level to 760 m elevation in Maharashtra, Gujarat, Kerala, Tamil Nadu, A.P., M.P. and part of U.P.

Climate : It is found in the semi-arid regions of 450-1500 mm rainfall zones.

Soils : It thrives best in black clayey soils and heavy loams, though it can grow on almost all types of soils in low lying areas, ditches, ponds along canals and river banks.

Cultural practices : The land is to be prepared properly by ploughing it well and the seeds to be sown @ 5-6 kg/ha by broadcasting or in lines at 50 cm distance by mixing it with soil after necessary fertilizer application as a basal dose. Rooted slips are preferable over seedlings where seed is not available.

Seed loses viability quickly after 12 months.

Fertilizer application : The natural *Iselema* grassland responds well to 40 kg N + 20 kg P₂O₅/ha. In established pasture N application may be increased upto 90 kg/ha for higher yield.

Forage yield : Under natural conditions the dry matter forage yield varied from 3.0 to 4.0 t/ha while in pure *Iselema* pasture an average yield of 4.9 t/ha was obtained under rainfed. In irrigated condition with the application of 90 kg N/ha (2 q ammonium sulphate) the yield boosted

upto 6.3 t/ha and it can further be increased upto 6.8 t/ha with same nitrogen and 16 kg P₂O₅/ha (1 q S.S.P.), Depending upon the moisture status of the site 2-3 cuttings may generally be taken under rainfed conditions.

Nutritive value : The grass is most nutritious and contains over 9.6 per cent C.P. at preflowering stage (July) which comes down to 5.2 per cent in September on dry weight basis, but the application of N fertilizer increases its C.P. content. Under different harvesting schedule the C.P. increased from 5.2 to 6.9, 7.5 and 9.6 per cent according to 60 days, 30 days, 20 days and 10 days clipping intervals respectively.

Utilization : The grass being nutritious is highly acceptable and palatable at all stages of its growth for grazing animals. This is also used for hay.

Lasiurus indicus Henr

Common name : Sewan grass (H)

Description : It is an erect, tufted and branched perennial grass and attains a height of about 1.2 m. The stem is stout, and smooth. Leaves are linear, 20-45 cm long with setaceous tip. Inflorescence is 10 cm long, white, densely villous and 3 spikelets at each node. Two spikelets are sessile and one is pedicelled. It is drought resistant and xeric in habit.

Distribution : It is native to India and found particularly in arid zones of Rajasthan, extending to the parts of Haryana and Punjab. It is also distributed in Arabia, Africa, Mali, Niger, Ethiopia, Egypt and Pakistan.

Climate : The dry arid climate suits to it with an annual rainfall from 125-250 mm.

Soils : It occurs on light brown sandy alluvial soils with a pH of 8.5.

Cultural practices : In a well prepared soil it is sown either through broadcast or in line at 50 cm distance with a seed rate of 5-7 kg/ha and 1.5 cm sowing depth. It is also established

through transplanting of rooted slips/seedlings at the distance of 2x2 or 2x3 m. Sowing or transplanting is done always during the rains or with 24 hours of rains. In first year one weeding improves the crop. The plants are protected from winds till they get establish.

Fertilizer : For its higher production 8-10 tonnes compost + 20 kg P₂O₅ are mixed during field preparation and 20 kg N/ha is applied after 30-40 days of sowing. Then 20 kg N + 20 kg P₂O₅/ha are applied every year.

Management schedule : During establishment it should be harvested once at 10-15 cm height but from 2nd year onwards it may be harvested 2-3 times depending on rainfall. The pasture may be maintained for longer period through rotational grazing.

Forage and seed yield : Average dry forage production of sewan grass is 2.5 to 3.5 t/ha in rainfed situation but improved strains under well management contributes about 7 to 8.5 t/ha dry forage in five cuttings in first year of establishment. The seed yield is 155-200 kg/ha in normal conditions.

Nutritive value : At flowering stage it contains 12.8 per cent C.P., 27.0 per cent crude fiber and 12.8 per cent ash.

Utilization : It is an extremely palatable grass and is used for hay, silage and grazing. It also

establishes sand dunes in desert areas.

Compatibility : It performs well with Tropical Kudzu (*Pueraria phaseoloides*).

Improved varieties : Recommended strains are CAZRI-317, 318, 319, 351.

***Melinis minutiflora* Beauv.**

Common names : Molasses grass, Venezuela grass (E).

Description : It is a tufted perennial grass of about 1.5 to 1.8 m high. The culms or tillers form a dense straggling mat. Leaves are flat, short, flushed red-brown in colour and covered with hairs, which exude a secretion with a strong molasses odour. This secretion does not spoil the milk or meat of the animals. Panicles are 10-30 cm long and purple. The spikelets are glabrous, 1.5 to 2.5 mm long. Awns are 6-16 mm long. Commercial seeds consist of a fertile and infertile floret which are small and fluffy because of awns. Seed count average 11 million/kg.

Distribution : It is a native of tropical Africa. It is introduced to many tropical countries as a fodder grass and now naturalized in Brazil, Australia, South America, India (coastal regions of Kerala) and Philippines.

Climate : This grass grows well in moist tropical climate. It requires moderate to high rainfall (750 to 1706 mm) with pronounced summer incidence.

Soils : It is found on light sandy to loamy soils of low fertility but may also be grown on clayey soils. It needs good drainage.

Cultural practices : In a prepared field the seeds of molasses grass are surfacely sown in rainy season @ 2.5 kg/ha in line or broadcast

after mixing these (seeds) with sawdust/rice hull for even distribution. The seeds have rapid and high germination. The seedlings spread quickly and smother most of the weeds. The crop attains vigorous growth from spring to autumn. The crop is susceptible to frost and may also be damaged by burning especially in autumn or winter.

Fertilizer application : It is a crop of low fertility soils and responds well to nitrogen and phosphorus.

Forage yield : The average dry matter yield of molasses grass is 4.8 t/ha. The forage yield may be doubled with the application of nitrogen (150 kg/ha) and phosphorus.

Nutritive value : At the initiation of flowers it contains 8.9 per cent C.P., 25.2 per cent crude fiber and 3.7 per cent ash.

Utilization : Being nutritive and palatable it is used for hay and silage purposes. It tolerates high grazing but heavy grazing thins it out. It forms a mat on the ground and checks the weed infestation and is also used in soil conservation programmes. It has insect repellent properties and is used as bedding for sitting fowls and bitches. Both odour and viscid hairs help in checking the mosquitoes.

Compatibility : Molasses grass combines well with legumes such as Glycine, Siratro, Centro and Desmodium. Among grasses it grows well with Guinea grass.

***Panicum antidotale* Retz.**

Common names : Blue panic, Giant panic, Sudan grass, Gramna, (E), Bansi (H).

Description : It is an erect deep rooted, thin stemmed, tufted perennial grass with smooth and

solid culms. Leaves are 45 cm long. Inflorescence is panicoid panicle, terminal, loose and pyramidal. The whole plant gives a bluish appearance. It is profuse seeder and seeds



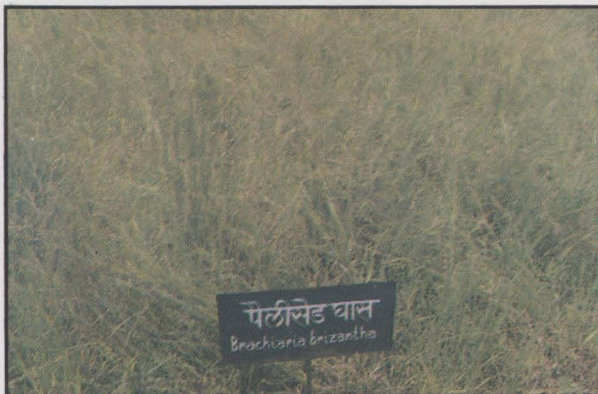
Bothriochloa intermedia



Cenchrus setigerus



Chrysopogon fulvus



Brachiaria brizantha



Chloris gayana



Panicum maximum



Eulaliopsis binata



Setaria sphacelata



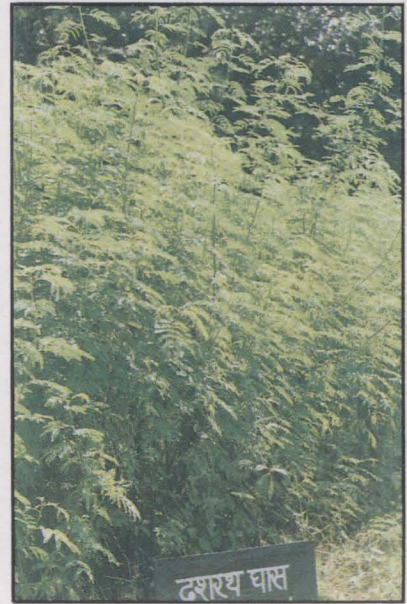
Lasiurus sindicus



Vetiveria zizanoides



Desmodium intortum



Desmanthus virgatus



Clitoria ternatea



Macroptilium atropurpureum



Indigofera hirsuta



Macroptilium lathyroides



Neonotonia wightii



Stylosanthes hamata



Stylosanthes humilis



Macrotyloma axillares

mature and shed easily in acropital manner. Seed count 1445000 per kg.

Distribution : It was recognised first in Australia and then was brought to India. It is widely distributed in arid and semi-arid regions of Afganisatan and Perasia. It is generally found with xerophytic bushes like *Caparis decidua*, *Calligonum polygonoides* in Rajasthan and in *Ziziphus nummularia* and *Mimosa himalayana* in U.P. (Jhansi).

Climate : The grass is highly adapted and grows well in dry areas to low hills. The rainfall ranging from 100 to 1000 mm is quite favourable for its growth.

Soils : All soils from light sandy to heavy clay as well as saline soils are quite suitable.

Cultural practices : Like other grasses, its pasture can be established easily by line sowing of seeds at 50 cm apart on well prepared land at the onset of monsoon. The seed rate is 6-7 kg/ha. Under irrigated conditions rooted slips of old tussocks may be planted in furrows at 50x50 cm apart. One or two weeding are enough for enhancing yield. Monthly irrigation is required for irrigated pastures.

Fertilizer application : It responds well to manuring and 10-15 tonnes FYM alongwith 30 kg P₂O₅ as basal dose and 20 kg N/ha after each cutting is recommended for optimum forage production.

Management schedule : Under rainfed conditions first cut of the grass can be taken in four months after seed sowing and subsequent cutting after 2 months, thus 4-6 cuttings in a year could be harvested, while under irrigation, fortnightly cutting is possible.

Forage yield : Under rainfed it gives 20.0 t/ha green forage in 4-6 cuttings while under irrigated conditions and proper manuring the green forage production is 50.0-60.0 t/ha in 10-12 cuttings.

Seed yield : Seed yield is 100-160 kg/ha under rainfed and 250-600 kg/ha under irrigated condition.

Nutritive value : The C.P. is quite high (7.3 per cent) with low P (0.09 per cent) and Ca (0.39 per cent).

Utilization : Generally it is recommended that the grass should be cut and fed for forage but it can also be used as pasturage. It is very fast in regrowth.

Panicum maximum Jacq

Common names : Guinea grass, Green panic (E)

Description : It is a tall erect, densely tufted, perennial tussocky grass having large number of tillers with short and stout rhizomes. The culms are 1.8 to 2.7 m tall, nodes densely hairy, leaf sheath pubescent. The leaf blade is 60 cm long and 2.5 to 3.8 cm wide and light green. Inflorescence is an open panicle, 50 cm long and 10 to 30 cm wide much divided with stiff branches in whorls. Seed count 17,50,000 to 22,00,000 per kg.

Origin and distribution : It is a native of tropical Africa and has spread to many warm countries like Australia, South States of USA and Philippines. In India it was introduced in 1793 in military farms.

Climate : Warm and moist climate of semi arid tropics is an ideal situation for this grass.

Soils : It grows best in well drained, medium and fertile soils under shades, but in high rainfall areas or under irrigated conditions it is found even on loamy soils.

Cultural practices : It requires well prepared land (2-3 times ploughed up with 3-4 harrowings). Pasture is easily established by planting rooted slips in lines at about 1 m distance in rows and 50 cm between plants during the rainy days in monsoon under rainfed conditions. When it is established through seed, 3-6 kg seed/ha (1-2 kg for Hamil) is required. One-two weedings are needed after establishment to check the weeds.

Fertilizer application : It is better to grow it along the irrigation channels, gardens and orchards etc. Being highly responsive to manuring 10 to 20 tonnes FYM + 30 kg P₂O₅/ha as basal dose, besides top dressing with 50-60 kg N/ha in two doses after every cut are given. After a period of 4-5 years the pasture needs to be replanted due to its ageing which can be done in the inter spaces of the standing crop.

Management schedules : Generally Guinea grass pasture is ready for first cut after 60 days of planting and subsequently at monthly (30-40 days) intervals.

Forage yield : It provides 50.0-60.0 t/ha (green) forage in 5-6 cuts under rainfed and 80.0-100.0 t/ha (green) under irrigated condition in 10-11

cuts. However at sewage irrigation 225.0 t/ha (green) forage may be obtained in 12 cuts.

Nutritive value : It contains 5-8 per cent C.P depending on the stage of clipping.

Utilization : This grass can be used both for grazing and soiling but being preferred for silage. It is the best to keep it below 1` m. height for maximum quality forage. After the pasture grazed, it can be cut back to 10-15 cm height for early regrowth. It is a better fodder than jowar and maize.

Cultivars : Its cultivars are Hamil panic, Coloniao, Makueni, Gramalote, Silky Guinea, Riversdale, Embu, Coarse Guinea, Common Guinea, Likoni Guinea etc.

***Paspalum dilatatum* Poir**

Common names : Water/Dallis grass, Golden crown grass (E)

Description : It is tall, tufted, tussocky, leafy at base, perennial grass and attains a height of 1.0 to 1.5 m. Inflorescence is spreading, 12-30 cm long with 2-5 spikes arranged digitately on rachis and 7.0 cm long. Spikelets are in 4 rows and 1.5 - 2.0 mm wide and 3.4 mm long. It has deep root system. It withstands close grazing and moderate frosts. Seed count 5,00,000 to 7,50,000 per kg.

Origin and distribution : It is native to South America (Brazil) and spreads over USA, Australia and India.

Climate : It is a grass of semi-arid climate where the total annual rainfall is from 780 to 800 mm. It is a drought resistant grass.

Soils : It grows well in rich moist soils of low lying areas.

Cultural practices : Being a vigorous perennial grass it can be easily established like other grasses through rooted slips in a well prepared land, so as to avoid initial weed competition. It has the potency to replace out *Imperata cylindrica* (an unpalatable grass) from a low lying

site, if planted successfully by dibbling method. It is tolerant to excess moisture and grows well in marshy localities where even *Cynodon dactylon* or *Iseilema laxum* are not successful.

It is a profuse seeder and 7-8 kg seeds are required to establish one hectare pasture.

Fertilizer application : It responds well to nitrogen fertilizer and 50-60 kg N/ha is recommended. Nitrogen application is essential after each cut.

Management schedule : The grass is suitable for grazing as well as for cutting in 75-80 days from establishment and subsequent cuttings may be taken at 40 days intervals.

Forage yield : The green forage yield varies from 50.0-60.0 t/ha.

Seed yield : It is 90-500 kg/ha. The seeds remain viable for two years.

Nutritive value : It is a nutritive grass and contains 6.7 per cent C.P., 0.27 per cent Ca and 0.14 per cent P at flowering stage.

Utilization : It is a good fodder grass and utilized for grazing and hay purpose.

Special feature : Drought resistant.

Paspalum notatum Fluegge

Common name : Bahia grass (E)

Description : It is a perennial, densely tufted grass and has short stout runners and well developed root system. Racemes two, spikelets obovate - elliptic, 3-3.5 mm long. In 1-kg seed the number varies from 330000 to 550000.

Origin and distribution : It is native to Brazil and distributed in Mexico, Texas South America and India.

Climate : It prefers warm and moist climate. It requires average 1500 mm annual rainfall.

Soils : It grows well on poorly drained and swampy soils (clay) or even on sandy soils.

Cultural practices : It can be easily established by pieces of stout runners like *Cynodon dactylon* and also by seeds. Runners are planted at 50x50-cm distance on well prepared moist land during a drizzly day. The seeds are sown at about 1 cm deep @ 10 kg/ha during monsoon. Due to waxy and tough seed coat germination is rather slow and seed scarification with H₂SO₄ is therefore recommended.

Fertilizer application : For higher forage yield 80-100 kg N per hectare is beneficial. Nitrogen application is also recommended after each cut.

Management schedule : Once established, Bahia grass can be grazed heavily to near soil level. It should be fertilized with nitrogenous fertilizer every year. Frequent defoliation over 24 months had little effect on sward. Cutting at six week intervals gave the best yield and nutritive value. In the early establishment period, mow the grass every three to four weeks to suppress weeds.

Forage yield : The crop is ready for cutting or grazing in 3 or 3 1/2 months after establishment and gives about 20.0-40.0 tonnes green forage in one hectare. Under good management subsequent cutting may be taken at a interval of 40-45 days.

Seed yield : The average seed yield is 110-350 kg/ha.

Nutritive value : At early stage it gives 11-12 per cent CP.

Utilization : It is used for grazing as well as stall feeding. Being a good soil binder it is also used in soil conservation programme.

Cultivars : Its main cultivars are common Bahia grass, Paraguay, Pensacola, Argentine, Wallace, Tampa, Tifhi-1, Tifhi-2, Wilmington and Tifton-9.

Pennisetum clandenstinum Hochst ex Chiov

Common names : Kikuyu grass (E), Seemak karayan (T)

Description : It is a perennial, rhizomatous, stoloniferous spreading grass forming dense mats on ground/hill slopes through numerous stolon and short internodes. Leaves are short 5-10 cm long, flat, glabrous or slightly hairy. Inflorescence is reduced to 2 to 4 spikelets and enclosed in upper most leaf sheath. Seed count 40000 per kg.

Origin and distribution : It is native to South Africa. In India it was introduced in 1919. Now it is found growing widely in hill slopes of Arunachal Pradesh near Bomdila at nearly 3000 m.

Climate : It prefers cool and moist climate upto the elevation of 1500 m. It requires average rainfall of 1269 mm every year.

Soils : It grows well in rich ioamy and acidic soils.

Cultural practices : This grass could be established by vegetative propagation through root runners planted at a distance of 75 cm apart on a well prepared and manured soil at the onset of monsoon. When established through seed 2-4 kg/ha seed is sufficient. The grass spreads rapidly by means of both surface and subterranean stolens. With a period of 3 to 3½ months the crop attains a height of 1 m and

whole of the field gets covered. It needs to be replanted after every two years, otherwise the plants become too hard for grazing and pasture loses the productivity.

Fertilizer application : At the time of field preparation 10-15 tonnes FYM/ha should thoroughly be mixed and afterwards 60 kg N/ha/yr in 2-3 splits produces optimum forage yield

Management schedule : First cut can be taken after 3 months of establishment and further cuts at an intervals of 1 -1 1/2 month may be taken.

Forage yield : The average total green forage yield is 35.0-40.0 t/ha.

Seed yield : In first year the seed yield is 25

kg/ha but in well established and under good management it is upto 500 kg/ha.

Nutritive value : At early stage i.e. 30 days after transplanting it is relished by all kind of animals. The average CP of the crop is over 12 per cent.

Utilization : Being highly nutritive and palatable it is a very good feed for dairy cattle. They relish it well due to its high leaf/stem ratio and succulent nature. It can stand close grazing. In addition to this the grass is very useful for erosion control on hills, since it is aggressive due to its spreading growth and has good soil binding capacity but care is needed as it spreads quickly and encroaches cultivated fields and it becomes difficult to eradicate it from fields.

***Pennisetum pedicellatum* Trin**

Common names : Kaysuwa (E), Dinanath ghas (H).

Description : It is an erect, annual grass of 0.7-0.9 m height. Culm is bright with light reddish at base. Leaves are 45-60 cm long and light to dark green in colour. Inflorescence is pink in beginning but becomes white at maturity. It is a heavy seed producer.

Distribution : It is distributed in West Africa and India particularly in Bihar, West Bengal, Haryana, Punjab, M.P. and U.P.

Climate : It prefers warm climate and is found in regions of rainfall ranging from 800 to 1250 mm.

Soils : It grows well on medium textured light soil and can grow on poor soils by giving sufficient fertilizer.

Cultural practices : At the onset of monsoon the sowing should be completed either in line or broadcasting using 4-5 kg seeds for one hectare area. Before sowing the soil should be mixed with seed. The pasture may be established by transplanting six weeks old seedlings at 50 cm distance from row to row and same for plant to plant. Thus 33000 seedlings are needed for one

hectare, planting 2 seedlings per hull. During first year 1-2 weeding in growing season help in better establishment of pasture.

Fertilizer application : During the field preparation 10 cartloads of FYM and 30 kg N (150 kg Calcium ammonium nitrate) + 30 kg P₂O₅ (187 kg single superphosphate) is applied as basal dose. After establishing the pasture top dressing of 30 kg N/ha increases the forage production. In subsequent years 30 kg N + 30 kg P₂O₅ are broadcasted and subsequently top dressed a month later with extra 30 kg N/ha after first shower of heavy rains.

Management schedule : In the first year of establishment it gives one cut in September. It is an annual crop but being profuse seeder, the crop comes every year by self seeding.

Forage yield : It produces about 100.0 t/ha green forage.

Seed yield : The seed production is upto 3-4 q/ha.

Nutritive value : It contains 7.4 per cent CP, 0.42 per cent Ca and 0.21 per cent P.

Utilization: It is used as fodder crop and is relished by all kind of livestock for grazing.

***Sehima nervosum* (Rottl.) Stapf.**

Common names : Rat's tail grass, white grass (E), Sain, Poona and Suekai (H), Sheda (Mr), Karaitoi and Vennai Pillu (T), Mendra gaddi (Te) and Sinnaisphadai hullu (K).

Description : It is a perennial grass forming dense tufts with numerous tillers, upto 1 m and above in height. Stems/culms are erect, hollow, slender, pale straw yellowish and bright on ripening. It has abundant and soft foliage. Leaves are 15-40 cm long, 0.8 to 1.5 cm wide with linear leaf blade. Racemes are solitary 7.5 to 15.0 cm long and erect or slightly flexed. Both sessile and pedicelled spikelets are awned. The awns are slender and twisted at base.

Distribution : It is widely spread in south-east Asia, Australia and East Africa. In India it is distributed in undulating areas of M.P., U.P., Gujarat, Maharashtra, Karnataka, Andhra, Tamil Nadu and from sea level to 1830 m elevation. It is also found in Arvalli Ranges of Rajasthan.

Climate : It prefers hot and dry climate in the rainfall zones of 250 to 1500 mm with an optimum upto 1000 mm.

Soils : Eroded, red gravelly/stony to medium sandy loamy soils are common of its availability. It is also seen on rock crevices of undulating topography and on hill slopes. The soil pH of its habitats is 6.5.

Cultural practices : In a well prepared land the pasture is established either by seed sowing @ 6-7 kg/ha in lines at 50 cm apart broadcasting or transplanting of seedlings/rooted slips at the onset of monsoon. Among these, transplanting of seedlings is more successful and for this about 1.33 lakhs seedlings are required for 1 hectare. Weeding is required at least twice in first year during growing season and this can be done in the form of interculturing between rows of grasses.

Fertilizer application : At first a basal application of 10 cartloads of FYM is required

followed by 20 kg N (100 kg Calcium ammonium nitrate) + 20 kg P₂O₅ (125 kg SSP) for one hectare. After one month of establishment a top dressing with another 20 kg N/ha is given. In subsequent years mixture of 20 kg N + 20 kg P₂O₅ /ha is beneficial after first shower of rains.

Management schedule : It is totally a rainfed crop. In first year only one cut should be taken in mid October. Meanwhile seed collection should be carried out for building the seed stock for further multiplication. In subsequent years two cuttings (mid August and late October) may be taken depending upon the pattern of rainfall distribution. One more cutting is possible during spring season in March or April.

Forage yield : Maximum forage (green) obtained from an unfertilized pasture is 16.0 t/ha with 61 per cent dry matter if harvested in September. Thereafter the dry forage yields as well as nutritive value declines due to leaf fall. In fertilized pasture the yield is nearly double of better quality.

Seed yield : Under well managed condition this grass produced about 110 kg seed/ha.

Compatibility : For higher and better quality forage, association of this grass with *Atylosia*, *Clitoria*, Siratro and Caribbean stylo is recommended. Every two rows of grasses one row of legume is maintained are transplanted at the space already mentioned above. This practice minimises the competition between the legumes and grasses for optimum establishment.

Nutritive value : It contains maximum CP (6.9%) in July and minimum (2.3%) in December. The calcium contents of the grass is highest (0.68%) among other forage grasses. The phosphorus content of the species ranged from 0.05 to 0.18 per cent.

Utilization : It is a good forage grass and may be utilized for grazing as well as for hay too.

***Setaria sphacelata* Stapf. ex Hubb**

Common names : Setaria, Golden timothy, Golden bristle grass (E) and Nandi (H).

Description : It is an erect, bunchy perennial grass growing to a height of 1.2 to 1.5 m with flattened culms. Leaf blades are flat, 30-45 cm long, 6-10 mm wide, linear and lanceolate. Inflorescence is terminal, compressed panicle about 15 cm long, appearing as a dense cylindrical spike and orange to purple in colour. Seeds count 1.4 to 1.7 million.

Origin and distribution : The name of this grass 'Setaria' is derived from Latin 'Seta' the meaning of this is numerous bristles on the inflorescence. It is native to tropical Africa and was introduced in India in 1950.

Climate : This is a grass of warm climate and is found in the rainfall zone of 1500 mm in plains.

Soils : It thrives well on fertile loamy soils and comes even on light soils (sandy-loam).

Cultural practices : It can be established by planting seedlings/rooted slips in furrows of 50 cm apart and 30 or 50 cm distance from plant to plant at the onset of monsoon. Under irrigated conditions its planting can be done in February - March in north India while any time in south on well prepared and manured fields. In case of establishment by seed, seed rate is 1.5 kg/ha for mixed pasture.

Fertilizer application : It shows linear response to manuring and generally 20 tonnes FYM alongwith 120 kg N + 60 kg P₂O₅ as a basal dose followed by 20 kg N/ha after every cutting

or 40 kg N/ha after every two cuts ensures high forage yield.

Management schedule : Generally the pasture is ready for first cutting after 3 months of planting (sowing) and subsequently it can be harvested at monthly intervals in a well irrigated and properly manured pasture. The cutting height may be kept between 5 to 10 cm from ground level.

Forage yield : The pasture of Nandi grass produced 22.8 to 23.8 t/ha green forage under rainfed condition but two protective irrigation increased the forage yield upto 61.2 t/ha with nearly 30 per cent dry matter content. This grass is more potential and under good management (well fertilized and irrigation), the pasture yielded 89.6 t/ha in 7 cuttings in south and 120 t/ha in north.

Seed yield : Cultivar Nandi yields 112 kg seeds/ha but the seed yield seldom exceeds 330 kg/ha.

Nutritive value : The grass is very leafy and quite palatable and highly nutritive. It contains 5.3 per cent CP in unfertilized pasture but the application of 30 kg N/ha increased CP (6.9 per cent).

Utilization : The grass can be used for soiling, hay or grazing particularly due to its good winter growth which ensures its sustained forage supply round the year, especially if intercropped with legumes such as stylos and siratro.

Cultivars : Nandi, Kazungula, Narok are its main cultivars.

***Tripsacum dactyloides* (L.) L.**

Common name : Guatemala grass (E)

Description : It is a densely culmed perennial grass with short fibrous and woody rhizomes. It has stilt roots, arising from lower nodes. Culms are stout, woody, solid, 3-4 m tall and 3-5 cm thick at base. Leaves are lanceolate-acuminate, 0.6 to 1.5 m long 3.0 to 10.0 cm wide and

glabrous. Inflorescence is about 30 cm long, terminal and axillary with 1 to 6 racemes. Seed count 15000/kg.

Distribution : It is a native of tropical America and now distributed in Florida, Mexico, Brazil and West Indies.

Climate : It is a species of hot climate and grows

well in a range of about 1000-1500 mm annual rainfall.

Soils : It is adapted to wide range of soils particularly moist, well drained and fertile soils.

Cultural practices : In a well prepared field the pasture is established through planting the seedlings and rooted slips in lines at about 1.0 m distance from row to row and 50 cm from plant to plant during rainy day in monsoon season.

Management schedule : Grazing is best if deferred after 90 days at every two to three years, to enable plants to produce seeds. Due to tough midribs of the leaves, the cattle have difficulty in biting and more over the shallow-

rooted plants are easily up rooted. It makes very little growth in dry weather.

Forage yield : In first year it yielded 25 t/ha green forage without fertilizer and this could be increased under good management (giving irrigation and fertilizers).

Utilization : It is palatable grass and provides a good fodder to all types of animals and is used as hay and is usually harvested at 10-20 cm height when the seed heads start appearing. This grass is extensively planted on rubber estates as a soil conditioner in drained swamps and for mulching. This is also used in soil conservation programmes.

***Urochloa mosambicensis* (Hack) Dandy**

Common name : Nixon sabai grass (E)

Description : It is a semi-erect, stoloniferous, perennial grass growing to a height of 0.6 to 0.9 m and spreading through runners. Inflorescence is of sessile and subsessile racemes. Seed count 60600/kg.

Distribution : This grass is distributed in East Africa and Burma. In India it was introduced in 1950.

Climate : It is a grass of low to medium rainfall (1500 mm or above) areas and sub-temperate climate.

Soils : It is found on wide range of soils from light to medium loam including saline and alkaline plains.

Cultural practices : The grass produces sufficient seeds and can be established by seeding (@ 4 kg/ha as pure and @ 2 kg/ha in mixed pasture) in lines at 50 cm apart, or by planting rooted slips in a well prepared land at the onset of monsoon as rainfed crop and in

Feb.-March in North India and any time in south as an irrigated pasture.

Fertilizer application : It is quite responsive to fertilizer application and yield can be increased many times.

Management schedule : First clipping can be done after 80 days of establishment and subsequent at an interval of 40-45 days. Thus it gives 4-6 cuts under rainfed situation and 10-11 cuts in irrigated conditions.

Forage yield : Forage production of this grass was recorded as 25.0 and 40.0 t/ha (green) under rainfed and irrigated conditions respectively.

Seed yield : Seed yield is 100-130 kg/ha.

Nutritive value : The grass is highly palatable and nutritive with nearly 11.0 per cent C.P. and balanced Ca (0.54 per cent) and P (0.41 per cent) on dry matter basis.

Utilization : It is used as forage grass and for soil conservation purposes also.

***Vetiveria zizanoides* (L.) Nash**

Common names : Vetiver grass (E), Ganrar, Khas (H), Panni (P) and Laamanche (K).

Description : It is an erect perennial, densely tufted, awnless grass. It has no rhizome or

stolons. The vetiver grass has deep and intensive spongy aromatic roots, which form a mat in sub surface strata of the habitat. The culms are stout, smooth and attain upto 2.0 m

height. Basal diameter is about 6 to 15 cm with tillers ranging from 6 to 30. Leaves are stiff, 30 to 75 cm long, 8 mm wide and green in colour. Inflorescence is conical panicle, 15-40 cm long, glabrous and often reddish brown or purple in colour. Spikelets are narrow, acute, appressed and awnless. One spikelet is sessile, hermaphrodite with short sharp spines and the other spikelet is pedicelled and staminate. Its seed producing ability is poor as well as seed germination percentage is also very low (10 to 15%) but dehusked seeds give about 50 per cent germination. It is a 'shy seeder' and is considered sterile outside its natural habitat.

Distribution : The grass is native of tropical and sub-tropical Asia and distributed in India, Burma, Shri Lanka and south-west Asia to tropical Africa as well as Brazil, China. In India it is found through out Gangetic plains, the Brahamputra valley and extends towards in the plains of Punjab.

Climate : It is a plant of semi-arid climate and is found growing in the areas having annual rainfall from 500-5000 mm. It can withstand extreme drought and ill drained (waterlogged) situations.

Soils : It thrives well in sandy loam to clayey soils with a pH range of 4 to 7.5. It may grow even on neutral to slightly alkaline soils too.

Cultural practices : On account of poor seed producing ability and low seed germination the Vetiver grass is mainly propagated vegetatively by root divisions or slips. Thus, for Vetiver grass, no intensive land preparation is needed. Rooted slips of Vetiver grass are transplanted during rainy season in even singly ploughed field at a distance of 10-15 cm from plant to plant. The grass tussocks should be dug and 15-20 cm top foliage and 10 cm roots from below the base should be cut which will improve the chances of

survival on planting by reducing the transpiration level and thereby preventing them from drying out. After these the tussocks should be divided into the pieces of 2-3 tillers. Although Vetiver grass can be planted from single tiller when planting material is scarce.

These slips should be planted at the beginning of wet season to ensure that they get full benefit of the rains. Holes are prepared at 10-15 cm or at required distance then these slips are pushed into these holes taking care not to bend the roots upwards and then firm the slips in soil.

Fertilizer application : Application of diammonium phosphate (DAP) encourages fast tillering and to do this in the field simply dibble DAP in to the planting furrow is done before planting the slips.

Management schedule : Once the plants are established, they need annual trimming to a height of about 30-50 cm. to encourage tillering and prevent shading of the food crops.

Utilization : The grass is not considered as a valuable fodder but it could be utilized/grazed by cattle in young stage. The leaves are much relished by buffaloes. In drought conditions this grass is utilized for fodder purposes. However, after flowering it becomes coarse, fibrous and unpalatable. Moreover the presence of Vetiver oil in the plant makes it somewhat distasteful to grazing animals and rodents.

It provides a seeping terrace, which slows the rate of run off, ponds water temporarily which in turn settles out most of the sediments. Therefore this grass may be very useful for soil conservation purposes. Besides the usefulness of its roots as Khus-khus tatties, the spikes of the plants are used for making brushes. Further, the whole plant can be utilized for thatching purposes as well as for paper pulp.

LEGUMES

***Atylosia scarabaeoides* Benth.**
Synonym - *Dolichos scarabaeoides* Linn.

Common name : Bankulthi (H)

Description : It is herbaceous perennial twiner with slender stem. All parts are clothed with gray downy pubescence. Leaves are tri-foliolate. Leaflets are obovate, oblong or elliptic and the lowest is longest. Flowers are yellow, pedicelled and 2-6 on short axillary peduncles. Pods are straight and 4-6 seeded.

Distribution : It is native of India and found in all parts of the country.

Climate : Bankulthi grows in 250-1000 mm rainfall zones of arid and semi-arid climates and is a drought and frost resistant.

Soils : It prefers a wide range of soils ranging from light to heavy even clayey soils with adequate drainage. It can tolerate salinity too.

Cultural practices : The area is totally cleared off from all bushes and rank vegetation. One ploughing is done by mould board plough followed by 2-3 harrowings. All the stones and other grass roots should be removed and planking is done for leveling the fields for pure stand or monocrop but in case of grass-legume mixture one field operation with cultivator is sufficient.

Seed treatment : Before sowing the seeds are put in boiled water (80° C) for 1 to 1.5 minutes.

Seed rate : In case of monocrop 10 kg and for grass legume mixture 6 kg/ha seeds are used.

Sowing : The treated seeds are sown in late June or mid July either in line or through broadcast at 0.8 to 1.2 cm depth. In lines the

seeds are sown at 50 cm distance in pure stand but at 1.5 m distance in mixed crop.

The seeds are covered by dragging a small branch or a twig of a tree to cover the seeds with a thin layer of soil.

Fertilizer application : In first year a basal application of 5 t/ha farm yard manure (FYM) + 10 kg N + 30 kg P₂O₅ /ha is given while in the subsequent years 30 kg P₂O₅/ha is broadcasted at the onset of monsoon.

Interculturing : During first year two interculture operations are required for the better establishment of the crop.

Management schedule : In first year only one cut is taken at the end of October but from second year onwards two or more cuts are taken depending on rainfall and its distribution. It should be harvested at 8 to 10 cm stubble height.

Forage and seed yield : Green forage production ranges from 8.0 to 12.5 t/ha. Its seeds are to be collected two times i.e. in October and April. The seed yield varies from 100 to 200 kg/ha.

Nutritive value : Its C.P. content ranges from 11 to 14 per cent while it contains 1.6 and 0.15 per cent Ca and P respectively.

Utilization : In addition to forage it is also used for soil conservation purposes.

Compatibility : It can be grown as mixture with *Cenchrus*, *Dichanthium* *Chrysopogon*, *Heteropogon*, and *Sehima*.

***Calopogonium mucunoides* Desv.**

Common name : Calopo (E)

Description : It is an annual creeper of 0.3-0.5 m height. Stem is succulent, covered with long brown hairs. Its lower part becomes creeper while upper part turns to twiner. Leaves are trifoliolate and hairy on both surfaces with oval leaflets of 5 cm length. Flowers are small pale

blue. The pod is hairy, yellowish-brown, 4-5 cm long. It contains 4-8 seeds. There are 73,000 seeds in 1 kg.

Distribution: It is a native of tropical South America but distributed naturally in Malaya and Indonesia. It was introduced in 1930 as a cover crop in India. It is well suited to Kerala coasts.

Climate : It has shown excellent performance under wide range of climate preferably hot, humid tropics with an annual rainfall in excess of 1525 mm. It is moderately drought and shade tolerant.

Soils : It is found on a wide range of soils with 4.5 to 6.5 pH.

Cultural practices : One deep ploughing with disc plough followed by two discings and planking are sufficient.

It is sown at the beginning of rainy season through broadcasting the seeds @ 6-8 kg/ha and then covered with soil but in line sowing the distance should be 1.2 to 1.8 m. It can also be propagated by planting the rooted slips.

Fertilizer application : It responds well to phosphorus application and recommended fertilizer dose is 20 kg N + 60 kg P₂O₅ + 30 kg K₂O/ha.

Seed treatment : To break the dormancy the seeds are to be treated through any of the following methods

- (i) Concentrated sulphuric acid (S.G. 1.8) for 20 minutes or with 24 or 36 N sulphuric

acid for 7 min. then wash and dry.

- (ii) Scarify with sand

- (iii) Infrared irradiation

Management schedule : It gives full cover in 2-3 months and can be harvested at 8 weeks intervals after establishment. Grazing can also be done rotationally at interval of 8-12 weeks.

Forage yield : The forage yield of calopo is 56 t/ha (green) and 14.5 t/ha (dry) in 3-4 cuttings.

Seed yield : 600-700 kg/ha.

Nutritive value : It contains 16 per cent C.P. on dry matter basis.

Utilization : It is used as a fodder crop and is less palatable at early stage but after flowering it becomes more palatable. Being fast grower it is good for soil conservation purposes.

In new mixed pasture, the Calopo can be sown after the grasses get established. It fixes 3.8 mg N/day per plant and 87 per cent of the fixed N is transferred to the top. It is frost and drought susceptible but is an excellent flood tolerant and grows well in acid soils.

***Centrosema pubescens* Benth.**

Common name : Centro (E)

Description : Centro is a perennial vine of trailing habit and in pure stands forms a dense cover of 0.4-0.5 m high in 4-8 months of sowing. Stem is dark green and remains succulent for 18 months. Leaflets are 2.5 cm long, slightly hairy on lower surface and oval in shape, flowers are showy, bright or pale lilac in colour. These are born in axillary racemes. Pods are straight or slightly twisted, dark brown and about 13 cm long which contain upto 20 brownish-black mottled seeds. The seed count is 40,000/kg.

Distribution : It is a native legume of tropical South America but found in most of the tropical countries of the world such as South-East Asia, Indonesia, Africa and Pacific Islands. In India it was introduced and well suited to west coast of the peninsula.

Climate : It is found in hot humid climate where the annual rainfall exceeds more than 1525 mm.

Soils : It thrives well in alluvial to medium fertile soils and is moderately tolerant to poor drainage.

Cultural practices : One deep ploughing followed by cross harrowings and planking are enough to prepare a good seed bed. Centro is sown in lines after first heavy rains in July. For pure stand the seed rate is 4-5 kg/ha but for mixed pasture the seed rate varies from 1.5 to 2.5 kg/ha. The seeds are hard and require hot-water treatment for 30 minutes. After this seed inoculation should be carried out for sowing. These are sown at 2.5 to 5.0 cm depth. It takes about four months for establishment, but once established it keeps on growing and needs little attention later on.

Fertilizer application : Alongwith normal fertilizer, additional dose of phosphorus is beneficial as it responds well to super phosphate and trace elements.

Management schedule : In first year only one cutting is taken in the month of November while in subsequent years 2-3 cuttings are obtained depending upon the rainfall and its distribution.

Forage yield : It ranges from 15 to 20 t/ha (green).

Seed yield : It ranges from 100 to 150 kg/ha.

Nutritive value : The C.P. content of the species varies from 12 to 15 per cent in winter and

reaches upto 23% in summer. It has high mineral contents.

Utilization : It is mainly used as cover crop in plantations and utilized as fodder crop. Older plants fix nitrogen effectively, increases soil nitrogen levels and the crude protein of associated grasses. Being deep rooted it is drought and flood tolerant.

Compatibility : It is successfully grown in mixture with grasses like *Panicum*, *Pennisetum*, *Digitaria*, *Brachiaria*, *Setaria* etc. Centrol/guinea grass pastures have maintained a good balance over a period of 20-25 years.

***Clitoria ternatea* Linn.**

Common names : Butterfly pea, Conch flower creeper, Mussel-sheel, Pea blue creeper (E), Aparajita, Gokarni (H), Kakattan, Kuvilai (T), Sankhulpushpi (MI) and Neel Gentana (Te).

Description : It is a beautiful climbing perennial herb. Stem is slender, rounded and hairy. Leaves are 7-10 cm long, alternate, oval or oblong, shortly pubescent underneath. Stipules are small and persistent. Flowers are bright, blue with orange or white center solitary and axillary. Pod is flat, linear, 8 cm long hairy and 6-10 seeded.

Distribution : It is native to tropical America and widely grown in warmer parts of the world.

Climate : It grows in rainfall ranging from 400 to 1500 mm but performs well under irrigation.

Soils : Adapted to a wide range of soil conditions from sandy to deep alluvial loams and heavy black cracking clays. It has tolerance to moderately saline soils.

Cultural practices : In a well prepared field the sowing should be done in first week of July with a seed rate of 15 to 20 kg/ha at a depth of 1.5 to 4.0 cm and lightly covered. Seeds require concentrated sulphuric acid of S.G. 1.8 treatment for 20 minutes to break the dormancy.

Fertilizer application : It responds well to fertilizer and for higher forage yield 10 to 15 kg N + 40-50 kg P₂O₅/ha should be given in the first year and afterwards, 30 kg P₂O₅/ha should be applied every year.

Management schedule : In the first year, it gives only one cut but in subsequent years depending upon the amount of rainfall and its distribution two or more cuts may be taken.

Forage yield : Dry matter yield varies from 1.1 to 3.3 t/ha in first year under rainfed condition while under irrigated condition it yields around 13.3 tonnes dry matter per hectare.

Seed yield : 50-75 kg/ha.

Nutritive value : The C.P. content ranges from 10.5 to 25.5 per cent on dry matter basis.

Utilization : Being most palatable, it is liked by all types of cattle and its poor persistency is often due to selective grazing. It is used as hay as well as for grazing. It should be grazed lightly and in rotations to preserve the pasture for longer period. The plant is also known for its ornamental, religious & medicinal values.

Compatibility : It grows well with tall grasses such as guinea and elephant grass.

Desmanthus virgatus (Linn.) Willd.

Common names : Hedge lucerne, Dwarf Koa, Desmanthus (E), Dashrath ghas (H)

Description : It is a small shrub, 2-3 m tall, glabrous with virgate branches. Leaves are bipinnate with 6-8 pinnae. Flowers are whitish, solitary, globose, peduncled. Pod is 5-8 cm long with 20-30 seeds.

Distribution : It is native to tropics and subtropics of the new world from Florida to Argentina. It is found throughout India.

Climate : It can grow in hot weather areas having rainfall ranging from 250 to 2000 mm. It is drought resistant and can tolerate moderate frost and water-logging for a short period.

Soils : It grows well on a wide range of soils ranging from light sandy to heavy soils. It is efficiently grown in calcareous soils and is tolerant to salinity too.

Cultural practices : After clearing the bushes and rank vegetation of the area the land is prepared during the onset of monsoon. In a well prepared field the seeds are sown @ 2-3 kg seeds/ha at a depth of 1.0 to 1.5 cm. The sowing is preferably done in lines at 30 to 50 cm distance.

Fertilizer application : Ten cartloads of FYM is mixed thoroughly. This is followed by the application of 15 kg N + 30 kg P₂O₅/ha. In

subsequent years 40 to 60 kg P₂O₅ and 15 to 20 kg N/ha is given basally at the onset of monsoon.

Seed treatment : The seeds should be treated with concentrated H₂SO₄ (sulphuric acid) for 8 minutes to break the dormancy.

Management schedule : In first year it should be cut once but in subsequent years it gives 2-4 cuttings. The cutting height should be 15 to 20 cm from ground level. After cutting it flowers in 45 to 50 days.

Forage & seed yield : The average forage yield in 4 cuttings ranges from 15 to 25 t/ha (green) while the seed yield varies from 180 to 350 kg/ha depending on soil type and climatic conditions.

Nutritive value : When cut at 8 to 9 weeks interval, the average C.P. content is about 15% on dry forage basis. The crude protein content of the whole plant, cut at 61, 91 and 122 days intervals was 10.6, 12.3 and 15.5 per cent respectively while the average C.P. of leaves was 22.4 per cent and of the stem 7.1 percent.

Utilization : It is a plant of high palatability, therefore widely used as forage crop. Fixes ample nitrogen. It is also being used as hedge and alley component in agroforestry.

Desmodium intortum (Mill) Fawc & Rendle

Common name : Green leaf desmodium (E)

Description : It is a large, trailing and climbing perennial; roots at nodes and has deep tap root; long, pubescent stems, branch freely and are often reddish brown. Internodes are shorter. Leaves usually have reddish brown to purple flecking on the upper surface. Leaflets are 2-7 cm long and 1.5-5.5 cm broad with a length width ratio of 1.4 to 1 and rounded. Inflorescence is fairly compact with deep lilac to pink flowers born in pairs. The pod is curved and contains 8-12 seeds. The pod adheres to animals and to clothing. The seed count 7,55,000/kg.

Distribution : It is native of Central and South America and widely distributed throughout the tropical and sub-tropical regions of Africa, Australia and the New World. It was introduced in India as forage.

Climate : It is best suited to sub-tropical coastal areas with an annual rainfall of 900 to 1275 mm and requires a long warm growing season.

Soils : It grows on a wide range of soils from light to clay loams with neutral to moderately acidic in reaction and is well adapted to poorly drained or water logged conditions. It has no

tolerance to salinity.

Cultural practices : Because of its small seed size, it requires well prepared field and can be established by drilling or broadcasting using 2.2 kg seeds/ha at 1 cm depth. It can be established even by cuttings, although the establishment is only 30 to 40 per cent but when these cuttings are rooted in banana fiber baskets under light shade, the results are good. These cuttings are transplanted at 1x1 m spacing.

Fertilizer application : It usually requires adequate levels of phosphorus (40-50 kg/ha) sulphur (15-20 kg/ha), potash (20-25 kg/ha) and Molybdenum for growth.

Management schedule : In first year the pasture should be grazed moderately thus leaving a large number of axillary buds for ensuring rapid regrowth.

Forage yield : Green forage yield is around 19 t/ha while average dry matter yield ranges from 5.8 to 12.5 t/ha depending upon the stage of the crop.

Seed yield : 80 to 100 kg/ha.

Nutritive value : It contains 13.1 per cent C.P., 0.34 per cent P and 1.44 per cent Ca.

Utilization : In addition to fodder value it builds up a good surface layer of organic matter which adds to the moisture holding capacity and fertility of sandy soils. It contributes large quantity of N to soil too.

Compatibility : It competes strongly with weeds and associates well with a number of grasses including *Setaria*, green panic, molasses grasses. Among legumes it grows well with siratro and glycine.

***Indigofera hirsuta* Linn.**

Common name : Hairy indigo (E)

Description : It is an erect or spreading annual and attains a height upto 1.5 m. Stem is cylindrical or ridged, densely clothed with long, fine, gray or reddish brown pubescence. Stipules are linear, setaceous, upto 1 cm long. There are 5 to 7 leaflets rarely nine which are elliptical, oblong, upto 40 mm long and 25 mm wide, the terminal one is longer than the lateral and pilose on both the surfaces. Inflorescence is dense, many flowered raceme, hirsute, 20-30 cm long including a peduncle more than 25 mm long. Bracts are linear to lanceolate upto 25 mm long. Pedicel is around 1 mm long. Calyx is stiff, brown about 4 mm long and hirsute. Corolla are white pubescent outside, brick-red or rose inside. Pods are straight rather tetragonal, 12 to 20 mm long about 2 mm wide, thickly hirsute with 6 to 9 seeds. Seeds are angular, cuboid and strongly pitted. Seed count 4,40,000/kg.

Distribution : It is distributed naturally in most parts of the world such as tropical Africa and America, southern Asia and northern Australia. In India it is found throughout the plains.

Climate : Generally it occurs in arid to semi-arid climate in the regions of 900 to 1700 mm annual rainfall.

Soils : It is best adapted to moderately acidic and low fertile sandy loam soils.

Cultural practices : The hairy indigo is sown in a well prepared field during early monsoon through broadcast with 6 to 10 kg seed/ha. This may also be drilled in close rows at the seed rate of 3-5 kg per hectare. At early stage weeding improves the crop.

Fertilizer application : Being well adapted to poor fertility soils, it has not shown major response to fertilizer application. Liming at upto 2000 kg/ha increased forage yield but not crown or root yield.

Nitrogen fixing ability : It has been estimated that the presence of *I. hirsuta* in mixtures is equivalent to the application of 126 kg/ha N per year on pure grass pasture.

Forage yield : The average dry forage yield of *I. hirsuta* ranges from 3.5 to 5.0 t/ha. It increased

about 50 and 100 per cent dry matter yield of pangola grass and *Setaria sphacelata* pastures respectively. It is a good seed producer.

Nutritive value : At early stage of growth it contains 15.2 per cent crude protein, 1.88 per cent Ca and 0.37 per cent phosphorus.

Utilization : Animals like it very much at early growth. It is also used for hay as well as for silage

purposes. Hay must be made early in season as, the stems become coarse and woody with age. The aftermath from such an early cut can then be grazed. Silage made from it satisfies only maintenance requirement. A good quality green manure may also be obtained from it.

Pest and diseases : It is resistant to root knot nematode and most insects and diseases.

***Lablab purpureus* (Linn.) Sweet**

Common names : Dolichos, Lablab bean, Hyacinth bean, Field bean (E), Sem (H).

Description : It is an annual or biennial legume and attains a height of 0.9 to 1.8 m. The stems are robust and well branched. Leaves are large trifoliate. Leaflets are oval 10-15 cm long smooth on the upper side and slightly hairy underneath. Inflorescence is loose and many flowered. Flowers are white, purple or reddish on axillary racemes. Pods are 3 to 12 cm long, curved with 2-4 big seeds. Seeds are globose, ovate or flattened, brown to black in colour with conspicuous white line at the hilum or point of attachment to the pod. Seed count 4000/kg.

Distribution : It is widely distributed in subtropical area of Africa, Central and South America, West Indies and many parts of South East Asia and Indonesia. It is found in most of the parts of India.

Climate : Warm humid climate is suited to it and grows well in the areas under 510-1500 mm annual rainfall. It is drought resistant.

Soils : It is found on a wide range of soils (deep sands to heavy clays) and pH (5.0 to 7.5).

Cultural practices : After a light soil working it

is sown at the onset of monsoon either in line or broadcast as pure crop (40 to 45 kg/ha) or mixed (20 to 25 kg/ha) with forage grasses. After sowing, the seed should be covered with soil. In beginning weeding is essential. The seeds are sown at 1.0 m row distance.

Fertilizer application : In well fertile soil no fertilizer is needed but in poor soils 10 to 15 kg N + 40 -60 kg P₂O₅ and 20-25 kg Potash/ha are applied for higher forage and seed production.

Forage yield : As pure crop its average dry forage yield is 2.0 t/ha but in well managed pasture it produces 5.4 t/ha dry forage.

Nutritive value : In this species about 11.74 per cent C.P., 37.67 per cent crude fiber and 39.47 per cent carbohydrate are found.

Utilization : It is palatable to all types of livestock and used for hay as well as for grazing purpose. It gives good silage with sorghum. Dolichos is also used as green manure and cover crop for soil protection against erosion.

Compatibility : Generally it is sown as a pure crop but some time with maize or sorghum at a wide spacing because of its slow growth.

***Lotononis bainesii* Baker**

Common names : Lotononis and Miles Lotononis (E)

Description : It is a creeping perennial and forms a dense pasture. Stem is slender, irregularly branched stoloniferous and 1.0 to 1.5 m long. Leaves are smooth digitately trifoliate

and central leaflet is rather larger than the other two. Inflorescence is racemes. Flowers are small bright yellow and born in a cluster of 8 to 23. Pod is oblong, 8-12 mm long, many seeded. Seeds are oval to heart shaped and vary in colour from yellow to green brown and magenta. The percentage of hard seed is fairly high. Purple

and brown seeds keep their viability better than yellow and green seeds. Seed count 33,00,000 per kg (a seed weights 0.26 mg of which 55 per cent is seed coat).

Distribution : Lotononis is native to South Africa and distributed to Australia and India.

Climate : It is adapted to tropical and sub-tropical climate with an annual rainfall in excess of 900 mm and 13.5 to 21 °C temperature. It is drought tolerant.

Soils : Lotononis thrives best to well drained acid sandy soils and tolerates temporary waterlogging and flooding.

Cultural practices : Being small seeded it requires a well prepared weed free field. Seeds are broadcasted in October-November and covered with a thin layer (5 to 6 mm) of the soil. The pasture is also established through cuttings at 2 to 2.5 m distance. Seeding rate is 0.5 to 1.0 kg/ha.

Fertilizer application : It responds well to fertilizer application and in poor soils 40 to 50

kg P₂O₅ and 30 to 40 kg Potash are applied in one hectare for higher forage. In acidic soils, calcium is mixed in first year.

Forage yield : Its dry matter yield varies from 1.8 to 5.0 t/ha while under irrigation the average dry forage yield of 8.2 t/ha has been recorded.

Seed yield : 33 to 55 kg/ha.

Nutritive value : It contains about 18.3 per cent C.P., 27 per cent crude fiber and 8.1 per cent ash.

Utilization : *Lotononis* is one of the most palatable tropical legumes and provides high yields of protein rich fodder to cattle. Under grazing conditions in mixed pastures, the grazing rotation is two weeks grazing four weeks rest. It is an excellent feed in winter because of its greenness and tolerance to frost.

Compatibility : *Lotononis* associates well with pangola grass, *Paspalum* and *Pennisetums*. Because of its unpredictable performance it should be sown with another legume in mixtures, e.g. *Desmodium* and Siratro

***Macroptilium atropurpureum* (DC.) Urb.**

Synonym - *Phaseolus atropurpureus* DC.

Common name : Siratro (E)

Description : Siratro is a deep rooted perennial herb and has trailing habit. Stem is hairy and root readily at the nodes. Leaves are trifoliolate, dark green and silvery slightly hairy on upper and very hairy on lower surface. Leaflets are somewhat oval shaped but the lateral ones are unevenly lobed. Inflorescence is raceme; peduncle 10-30 cm long with a cluster of 6-12 flowers, often paired, deep purple in colour. Pods are straight, cylindrical, pointed, 8 cm long many seeded. Pods dehisce violently when ripe. Seeds are flattened, brown to black in colour and 4x 2.5 x 2 mm in size. The seed count 75000 per kg.

Distribution : The species is native to central and south America and is now distributed to Australia, South East Asia and Pacific Islands. In India it is found in semi-arid regions.

Climate : It is adapted to sub tropical to tropical

climates and is found in areas of 615 to 1800 mm rainfall and 26.5 to 30 °C temperature.

Soils : Siratro thrives well on wide range of soils from light textured sandy soils to heavy clays with good drainage. It grows over a range of pH from 4.5 to 8.0 and even in moderately saline soils.

Cultural practices : For natural grassland or already established pasture seed should be sown after interculturing at the onset of rains. For pure pasture seed rate is 12 kg/ha but for mixed it is 6 kg/ha. Seeds are sown in July after first heavy shower either in line at 50 cm space or broadcast. Sowing depth is 1.0 to 1.5 cm. During monsoon one interculturing or weeding improved the crop performance.

Fertilizer application : In beginning 10 cart loads of FYM is thoroughly mixed in soil followed by 10 kg N and 30 kg P₂O₅/ha. In subsequent years 30 kg P₂O₅/ha is broadcasted at the onset

of monsoon. On fertile soils, no fertilizer will be necessary for a number of years.

Forage and seed yield : The average green fodder yield ranges from 15 to 20 t/ha and dry fodder from 3 to 5 t/ha. It produces the seeds two times in a year i.e. October-November and April-May. The total seed production is 50-100 kg/ha.

Nutritive value : It gives high yields of palatable protein rich fodder with 16.8 per cent C.P., 33.4

per cent crude fiber and 9.8 per cent ash.

Compatibility : It fixes nitrogen very effectively and can be grown with a wide range of grasses such as Rhodes, Setaria, green panic and guinea grass.

Utilization : It is utilized as hay and for grazing purpose and is persistent under heavy grazing when the plants are well established. It is also used for silage. Due to heavy and fast leaf fall it helps in improving the soil and used for checking the soil erosion.

***Macroptilium lathyroides* (Linn.) Urb.**

Syn. Phaseolus lathyroides

Common names : Phasey bean, Wild pea bean (E)

Description : Phasey bean is an erect annual or biennial legume and attains a height of 0.6 to 0.9 m. Branches are clothed with long deciduous hairs. Leaves are trifoliate and leaflets are smooth, oval shaped and 5-8 cm in length. Flowers are red purple and are attached on alternate side of the flowering stalks. Pods are cylindrical, slightly curved 8-10 cm long. Each pod contains upto 20 seeds, which are oblong, mottled and dark gray brown. Under favourable conditions it regenerates from seeds. Seed count 1,19,000/kg.

Distribution : It is native to India but has now spread to many tropical and sub-tropical countries.

Climate : It is adapted to sub-tropical areas with 25/30 °C optimum temperature and 760 to 2030 mm annual rainfall.

Soils : Generally it grows well on fertile soils (deep sandy to heavy clays) but also tolerate infertile, acid to saline and alkaline soils with even poor drainage.

Cultural practices : Although it is a summer

growing crop and sown in well prepared fields at the commencement of rainy season. The seeds can be broadcasted at surface or drilled no deeper than 1.25 cm and then covered lightly with soil. The seed rate is 2.2 to 3.3 kg per ha.

Fertilizer application : On fertile alluvial soils or heavy clays, it does well without any fertilizer but on poor sandy soils, 250 kg/ha molybdenized superphosphate is required.

Forage and seed yield : Its green forage yield is from 15 to 20 t/ha. From a mixed pasture of *M. lathyroides* and *Paspalum commersonii* about 5.4 t/ha dry forage was obtained. Seed yield is 200 to 250 kg/ha.

Nutritive value : It has good nutritive value and contains 19.2 per cent C.P. and 32.3 per cent crude fiber.

Utilization : It is less palatable in young stage but animals like it for grazing after the seeds have set. It is also used for hay as well as for silage purpose.

Compatibility : It can be grown successfully with a number of grasses like para, green panic, serobic grass. Seedlings are susceptible to bean fly.

***Macrotyloma axillares* (E. Mey.) Verdc.**

Syn. Dolichos axillaris

Common name : Archer dolichos (E)

Description : It is a summer growing trailing and twining perennial legume. Stem is cylindrical

and hairy. Leaves are trifoliate, oval, 4-5 cm long leaflets which are hairy on both surfaces. Flowers usually born in threes and are greenish

yellow. Pods are hairy, slightly curved, 3-5 cm long and contain 6-8 seeds which are oval and mottled. Seed count 20,000/kg.

Distribution : It is widely spread in tropical Africa and also in Sri Lanka. It became popular for commercial use in 1960.

Climate : This legume is well adapted to a frost free subtropical or tropical climate with an annual rainfall of 1000 mm.

Soils : It grows on variety of soils from sands to clays with good drainage. It requires a pH in excess of 5.5. It tolerates salinity.

Cultural practices : In a well prepared field the seeds are sown in line or may be broadcasted at the rate of 2-2.5 kg/ha as a pure stand and 0.5-1 kg in mixture at a depth of 1-2.5 cm during late spring to summer. It may grow even from cuttings in roughly prepared fields. Seeds may be dispersed through cattle dung and stands may thicken up from self-sown

seedlings. It is drought tolerant and survives in areas with a 6-8 months dry season.

Fertilizer application : It responds well to phosphorus and for higher production 120 to 250 kg/ha super-phosphate is recommended.

Forage yield : Its dry forage production is 15.5 t/ha.

Seed yield : Seed production is poor because of sparse flowering. Generally, 100-150 kg/ha seed is obtained.

Nutritive value : It contains 11.9 per cent C.P. in full growth which declines to 6.2 per cent at seed formation stage.

Utilization : Animals do not like it initially but afterwards they relish it much. It fixes ample nitrogen in the soil.

Compatibility : It grows well with pasture grasses viz., *Setaria*, *Paspalum*, *Rhodes* and *Panicum* spp.

Neonotonia wightii (Grah. ex Wight & Arn.) Lackey
Syn. *Glycine wightii* (Grah. ex Wight & Arn.) Verdc. and
G. javanica L.

Common name : Glycine (E)

Description : It is trailing perennial vine. It has deep root system and trailing stem produces the roots at nodes as soon as it comes in contact with soil. Stem is slender, hairy and well branched. Leaves are pinnately trifoliolate with 5-10 cm long and 3-6 cm wide leaflet and short hairs on both sides. The flowers are creamy white. The pods are hairy, straight or slightly curved, 1-4 cm long with 3-8 seeds. Average seed count 1,55,000/kg.

Distribution : It is native to Kenya and other African countries and spread over Ethiopia and tropical Asia.

Climate : It requires an annual rainfall of 760 to 1525 mm.

Soils : It prefers fertile, heavy black soils with good drainage. It does not tolerate water logging and high acidity conditions. It tolerates soil pH upto 6.5.

Cultural practices : The glycine seeds should be sown in well prepared fields by broadcast during rainy season or in lines at 1-2 cm depth and with 4-6 kg/ha seed rate. In case of line sowing the distance of line to line should be 50 cm to 1 m.

Fertilizer application : In first year 40 to 50 kg P₂O₅, 20 to 25 kg Potash and 15-20 kg N/ha are applied while from second year only 40 kg P₂O₅/ha is sufficient.

Forage yield : The forage yield depends on soil type and climatic condition. It produces 50 t green forage in one hectare while dry matter yield varies from 8 to 10 t/ha.

Seed yield : In rainfed condition, the seed yield is 330 kg/ha while only 110 kg/ha seed yield was found after one cut. Under irrigated conditions it gave 500-750 kg/ha.

Nutritive value : The average C.P. content ranges from 16.2 to 20.4 per cent in whole plant

while it was 26.5 per cent in leaf.

Utilization : It tolerates lenient grazing in first year and provides good feed to livestock.

Compatibility : Rhodes, green panic, guinea and molasses grass are suitable companion grasses.

Pueraria phaseoloides (Roxb.) Benth

Common names : Puero, Tropical Kudzu (E)

Description : It is a deep rooted perennial legume of twining and climbing nature. Stem reaches upto a length of 7 to 9 m and the young shoots are densely covered with brown hairs. The stems give rise to roots from nodes when come in contact with soil. The leaves are large and trifoliate. The leaflets are thin, triangular to oval-shaped, 5-8 cm long and densely hairy on lower surface. Flowers are deep purple. Pod is hairy, cylindrical, slightly curved, 8-10 cm long and black when mature and contains 10-20 seeds. Seeds are squarish with rounded corners and brown to brownish black. Seed count 81500/kg.

Distribution : It is native to South-East Asia and distributed in Malaysia and Indonesia. In India it is adapted to warm humid regions.

Climate : It is suited to humid zones of tropics and grows well in the areas of annual rainfall above 1500 mm and 15°C optimum temperature. It is easily killed by frost.

Soils : It has adaptability to a wide range of soils from sand to clay with 4 to 5 pH. It is not tolerant to salinity.

Cultural practices : In a well prepared field the seeds are generally broadcasted or drilled under warm and high moisture condition. In pure pasture the seed is used @ 3 to 6.0 kg/ha but in mixture the seed rate is only 1 to 2 kg/ha. The seeds are sown at 1.5 cm depth. It is mainly raised by seeds but can be propagated through

cuttings by planting two pieces at 0.7 to 1.0 m distance. For a better pasture it is established earlier than grass species. It is susceptible to frost but new shoots are put forth in following spring from the old root stocks.

Fertilizer application : Application of 2.5 t/ha calcium, 100 kg N/ha, 110 kg P₂O₅/ha and 100 kg potash/ha increased the forage production significantly. These nutrients have their pronounced effect on nodulation.

Management schedule : It gives 2-3 cuttings and is recommended to cut at the height of 25 cm from ground. It should be grazed leniently at all the time to maintain the composition, but when it dominates, the grazing pressure can be increased.

Forage and seed yield : The average dry matter yield was found to be 4.1 t/ha but in 3 cuttings it reaches to a value of 9.6 t/ha. In a mixed pasture of molasses grass puero contributed 9.1 t/ha (dry matter) of the total (22.9 t/ha). Its seed production is 300 kg/ha. Plants produce more seeds when grown on support structures.

Nutritive value : It contains 19.0 per cent C.P., 8.4 per cent fiber and 22.6 per cent dry matter.

Utilization : Being rich in protein it is liked by all types of animals, therefore, it is utilized as hay as well as for grazing and silage purposes.

Compatibility : It grows well with molasses grass, para, guinea and elephant grasses.

Stizolobium deeringianum Bort.

Common names : Velvet bean (E), Makhmal sem (H)

Description : It is a fast growing annual climber or runner and spreads the branches upto 10 m. Leaves are trifoliate, smooth, 20 to 25 cm long

and 7-12 cm broad. Flowers are white to violet in colour. Pods are curved, 10-20 cm long, much hairy and 3-6 seeded. Seeds are white to black in colour, 1.2-1.5 cm long, 0.9-1.1 cm wide. Seeds count 2000/kg.

Distribution : The species is native to South Asia and is now introduced in most of the tropical countries. In India it is found in many parts.

Climate : It thrives well in warm, moist conditions in the zones of 650-2500 mm annual rainfall.

Soils : It grows in all types of soils but prefers sandy to sandy loam. It may be grown even in acidic soils.

Cultural practices : The sowing should be done during monsoon in the month of July in rows with 50-60 kg seeds/ha at 50 to 75 cm distance but for a mixed pasture the seed rate is 22 to 30 kg/ha. Sowing depth is recommended from 6-8 cm. The crop becomes ready for first cut in 3 to 4 months.

Fertilizer application : Generally 10-15 kg N + 40-60 kg P₂O₅/ha is given.

Forage and seed yield : The green forage yield fluctuates from 15 to 25 t/ha. The seed yield is 1000 to 1500 kg/ha.

Nutritive value : It is very nutritive fodder and contains 15.6 per cent CP, 34.4 per cent crude fiber, 1.2 per cent Ca and 0.165 per cent phosphorus.

Utilization : Being nutritive and palatable it is used as fodder crop. It is also used for soil conservation purposes and green manure too.

Compatibility : It is grown with guinea and Rhodes grass.

***Stylosanthes guianensis* (Aubl.) Sw.**
Syn. *S. gracilis* H.B. & K.

Common names : Stylo, Schofield stylo, Fine stem stylo, Brazilian lucerne, tropical lucerne (E).

Description : It is a herbaceous perennial and 0.6 to 1.8 m tall. Cv. Schofield is an erect and becomes more prostrate under grazing while Cv. Oxley (fine stem stylo) is semi-prostrate with strong tap root system and has well-developed crown, fine stem and smaller leaflets with buds both below and above ground level. In earlier Cultivar stem is hairy and becomes woody at base with age. Leaves are trifoliolate. Leaflets are narrow, deep green with few hairs (oxley), elliptic and sticky (Schofield), 15 to 55 mm long and 3 to 13 mm wide. Flowers are small, terminal and yellow. Pods are flattened, single-seeded with small and coiled beak. Seeds are kidney-shaped yellowish-brown and 1.75 mm long. There are 2,64,000 seeds in 1 kg.

Distribution : It is a native of Brazil, introduced in West Indies, Africa, India and Pacific Islands.

Climate : It is suited to a warm humid climate with a temperature range of 15 to 29°C and withstands upto 43°C. It prefers an area, receiving a total annual rainfall in excess of 1525 mm. However, the Cultivar oxley is suited to lower rainfall (625 to 875 mm) conditions.

Soils : It grows well on a wide range of soils from coarse sand to sandy loams but not so well on heavy clays. It is not tolerant to salinity.

Cultural practices : For a better establishment the field should be well prepared and made free from weeds. At the commencement of rains inoculated seeds are drilled at 1 to 1.5 cm depth or broadcasted @ 3.5 to 5.0 kg/ha. Stylo can be established even on less/lightly prepared fields by broadcasting the seeds. After sowing, the seeds are covered by dragging a twig over the areas.

It may be established in natural grasslands, even by planting the cuttings at a distance of 1 to 2 m during the rainy days. At each spot 3-5 cutting, having at least 3 nodes, should be buried inside the moist soil. In natural grasslands over seeding is quite successful particularly on sandy soils in areas of adequate rainfall.

Fertilizer application : Stylo is efficient in extracting phosphorus as well as calcium from soils and is often not fertilized but it responds well to super phosphate. At the time of its establishment about 5 to 8 t/ha FYM should be mixed thoroughly in the soil alongwith 20 kg N + 30 to 40 kg P₂O₅/ha. From second year the application of 30 kg P₂O₅/ha is sufficient. Lack

of phosphorus causes yellowing of the leaf tips in the seedlings, small leaves and eventual death of young plants.

Management schedule: In the first year of its establishment it should be cut after 4 months from sowing but from second year onwards, for higher production, it may be cut 2-3 times at the height of 10 cm. The cattle prefer grazing the stylo sward in late autumn and early winter, when it is drying off and this is the time when it is a valuable feed. The grazing should be avoided during the establishment year but if it is grazed, it should be grazed lightly after 6-8 weeks from establishment to promote tillering. Rotational grazing (1 week on and 4-8 weeks off) is best for its long persistency. In late stage it becomes woody and not preferred by animals.

Forage yield: Its green forage yield varies from

15 to 41 t/ha in different soil types and climatic conditions while the dry matter yield ranges from 4.1 to 7.0 t/ha.

Seed yield: The seed yield recorded ranged from 70 to 200 kg/ha.

Nutritive value: The C.P. ranges from 12.1 to 18.1 per cent from whole plant (7.9 per cent for stem and 13.6 per cent for leaf). The crude fiber is from 21.7 to 37.7 per cent.

Utilization: It is used for hay, silage and grazing purposes.

Compatibility: Stylo combines well with guinea grass, spear grass, Rhodes and buffel grass, molasses grass, Setaria, para grass. It also persisted with Kikuyu grass. If pasture is short, it is compatible with other forage legumes viz., puero, centro and siratro.

Stylosanthes hamata (L.) Taub.

Common names : Carribean stylo and Verano stylo (E)

Description : Carribean stylo is herbaceous and dichotomously branched perennial. It attains a height of 1.2 m. The stems have short white hairs down one side. Leaves trifoliate, leaflets lanceolate, acute, glabrous with 4-6 pairs of veins, rachis 4-6 mm long and bidentate stipules adnate to the base of the petiole with hairs on the sheath and teeth. The inflorescence is an oblong spike with 8-14 yellow flowers on a long stem. The pods or so called seeds are medium to dark brown in colour, 2-2.5 mm long asymmetrical by reniform, radical ends fairly prominent and beak is slightly coiled. Actual seed comes after removing the brown covering and is light yellow in colour. In appearance it is similar to Townsville stylo. The seed count 450000/kg.

Distribution : It is a native of the islands of West Indies and found generally adjacent the coastal regions of North and South America, and introduced in many tropical regions of Australia, Burma and India.

Climate : It thrives well in the areas receiving

annual rainfall from 500-1270 mm with a pronounced dry season.

Soils : It is adapted to a wide range of soil types and is drought resistant.

Cultural practices : In a well prepared field the seeds are broadcasted or sown in line at 50 cm apart @ 5-6 kg/ha in pure and 3-4 kg/ha in mixed pasture during the early rainy season. The seeds should be covered slightly with soil by dragging the twig. During the establishment year 1-2 weeding and interculturing are required for better growth.

Seed treatment : Before sowing, the seeds should be scarified or treated with hot water for 1-1.5 minutes.

Fertilizer application : At the time of field preparation and before sowing 5 to 8 t/ha FYM + 10-15 kg N and 30 kg P₂O₅/ha are applied. From second year onwards 30 kg P₂O₅ and 15 kg N/ha are sufficient.

Management schedule : During establishment year (first year) it should not be grazed at all but should be harvested at the height of 10 cm from ground level after four months of sowing. From

second year onwards it may be grazed or harvested 2-3 times. Rotational grazing is preferred for higher production.

Forage yield : The green forage production ranges from 20 to 30 t/ha while the dry forage is 6 to 10 t/ha.

Seed yield : It generally produces 350 to 400 kg seeds/ha but from well managed pasture seed production reaches upto 1000 kg/ha.

Nutritive value : It contains 10-14 per cent C.P., 0.61 to 1.72 per cent Ca, 0.10-0.12 per cent P and 7.0 to 14.2 per cent ash.

Utilization : It is grazed in situ. Being nutritive and palatable it is used as feed for all types of animals in the form of hay, silage.

Compatibility : It may be mixed with *Cenchrus*, *Dichanthium Heteropogon Sehima*, *Chrysopogon* Nixon Sabai grass and Blue panic.

***Stylosanthes humilis* H.B. & K.**

Common names : Townsville stylo, Townsville lucerne, and Wild lucerne (E).

Description : Townsville stylo is an erect annual and attains an average height of 0.7 m. The stem is much branched and fibrous. Leaves are trifoliate. The leaflets are narrow, pointed, lanceolate and without hairs. The flowers are small and yellow and borne in a cluster of 5-15. Pod is hairy. Seed is small, angular, grooved across the middle and bears a stiff hooked bristle at one end, which facilitates seed spread. In case of caribbean stylo the bristle is not so much coiled as in Townsville stylo. The seed count 4,40,000/kg.

Distribution : It is the native to north-east Brazil and Venezuela. It is now widely spread in Tropics. In India it was introduced from Australia in 1960.

Climate : It is species of sub-humid, semi-arid to dry climate. It grows well in a temperature range of 15/10 °C to 27/22 °C and in areas with 510 to 1270 mm annual rainfall. It flourishes well in warm conditions.

Soil : It is adapted to wide range of soils but prefers sand and sandy loams. It may grow on acidic soils and even on well drained heavier type of soils. It has fair tolerance to salinity.

Cultural practices : For a pure or mixed pastures the land is prepared thoroughly by discing and ploughing the field 2-3 times but for natural grassland the rank growth is removed either by heavy stocking or burning and then the fields are lightly ploughed up. The seeds are sown in line or broadcasted @ 5 to 6 kg/ha for

pure pasture or 3 to 4 kg/ha in mixed and natural grasslands. In pure pasture one weeding is helpful.

Fertilizer application : It is extremely responsive to application of superphosphate and efficient in extracting phosphorus and calcium from soils. At the time of establishment it requires heavy dose of phosphorus but from second year onwards 40 kg P₂O₅/ha is sufficient. Molybdenized phosphorus increases the nitrogen content of the plant.

Seed treatment : For higher germination and better establishment the seeds are scarified with a paper or treated with hot water for 1 minute.

Forage yield : In pure pasture the green forage yield varies from 12 to 18 t/ha while dry matter yield is from 4 to 6 t/ha.

Seed yield : The average seed production is 400 kg/ha. Under well management higher seed (1200 kg/ha) production may be obtained.

Nutritive value : Its chief advantage is its nutritive value in winter and dry season. It contains 14.2 per cent average C.P. (12.3 to 17.7%), 30.0 per cent crude fiber (25.5 to 36.2%) and 1.4 per cent fat (0.7 to 2.5%).

Utilization : *S. humilis* makes quite good hay. It is also utilized for grazing purposes. It is not eaten during the young stage

Compatibility : It associates with *Cenchrus ciliaris*, *C. biflorus*, *Heteropogon contortus*, *Urochloa mosambicensis*, *U. bulbodes* and *Dichanthium aristatum*.

***Stylosanthes scabra* Vog.**

Common names : Shrubby stylo, Scabra stylo (E)

Description : It is an erect and woody perennial. It is dark green in colour and slightly sticky/viscous in feeling. It attains a height of 1.0 to 1.5 m. Stems are hairy and rough. Leaves are trifoliate and leaflets are small and broad (1.8 x 0.6 cm). The flowering is late (Oct.-Jan.) and flowers are small and yellow. The pod is 4.4 cm long and 1.4 cm broad, gray and one seeded. The pod bears minute hook. The seed is yellow to light yellow. The plant is highly frost susceptible. Seed count 360000/kg.

Distribution : It is a plant of tropical origin and distributed in many countries like Kenya, Brazil, and Queensland. It was introduced in India in 1965 from Australia.

Climate : It thrives well in warm tropical climate with 325 to 1200 mm annual rainfall.

Soils : It is grown on all types of soils with good drainage. It may be grown even on saline soils.

Cultural practices : In a well prepared field the seeds are sown in line at the distance of 50 cm or may be broadcasted @ 10 kg/ha for pure pasture. One weeding improves the crop. But in natural grassland or in mixed pasture after

one ploughing 5 to 6 kg seeds are sown in 1 ha.

Fertilizer application : At the time of field preparation 5 to 8 tones compost + 10 to 15 kg N and 30 kg P₂O₅ are mixed in soil before sowing. From second year onwards only 30 kg P₂O₅/ha is applied every year for higher quality forage.

Management schedule : At establishment year it should be harvested once in late January or early February and after second year onwards 2 to 3 cuttings may be taken.

Forage and seed yield : Its green forage production ranges from 15 to 25 t/ha while dry matter yield is 5 to 8 t/ha. Seed yield is around 1200 kg/ha.

Nutritive value : It contains 9.0 to 12.0 per cent crude protein.

Utilization : It is used for grazing and gives high quality hay and silage. But it is less palatable as compared to Townsville and Carribean stylo. It improves the soil by increasing the organic matter and nitrogen content of the habitat.

Compatibility : It may be grown successfully with *Chrysopogon fulvus*, *Panicum antidotale*, *Dichanthium annulatum*, *Cenchrus ciliaris*, *Heteropogon contortus* and *Urochloa* sp.

***Vigna luteola* (Jacq.) Benth.**

Common name : Dalrymple vigna (E)

Description : It is a short lived, summer growing, leafy perennial with climbing and twining habit. Stem is sparsely hairy and sends or gives rise to roots as it comes in contact with moist soil. Leaves are trifoliate and leaflets are ovate lanceolate, 2.5 to 10 cm long and 1.5 to 5.0 cm broad, dark green and sparsely pubescent at both sides. Inflorescence is axillary raceme and flowers are yellow. Pods are pendant, thin shelled with waxy margins when dry and 5 cm long. Pod contains 6 to 9 seeds, which are black to brown in colour and 3 to 4 mm long, and 2 to 3 mm broad. Seed count 37000/kg.

Distribution : It is a native to coastal and swampy areas of Africa, Central and South America. Now it is introduced in Argentina, Australia, India and in other countries.

Climate : The optimum temperature for its growth ranges from 20 to 30 °C. A minimum annual rainfall of 1525 mm is required.

Soils : It is adapted to wide range of soils and is highly successful on wet and poorly drained soils. It also tolerates saline conditions.

Cultural practices : It requires well prepared field and the seeds are sown in wet soil @ 8 to 12 kg/ha in pure and 4 to 6 kg/ha in mixed

pasture preferably in line at 1-2.5 cm depth.

Seed treatment : A light mechanical scarification assists in seed germination.

Fertilizer application : For its higher forage production 40 to 60 kg P_2O_5 and 20 to 35 kg Potash/ha are applied every year.

Management schedule : It flowers in late autumn and early winter. The pods mature in early spring. Seed harvesting is little bit difficult because the pods are hidden in new vegetative growth before they mature.

Forage yield : The green forage yield varies from 12 to 18 t/ha while its dry matter production is from 1.9 to 2.5 t/ha.

Nutritive value : It contains 17.4 per cent C.P., 1.27-1.91 per cent Ca, 0.10-0.19 per cent P and 9.6-16.8 per cent ash.

Utilization : It is extremely palatable plant at all stages of growth but should be grazed leniently for longer persistency.

Compatibility : It grows quite well with *Paspalum* and *Setaria* spp. in moist situations.

Range grasses, legumes for different agro climatic regions of India

Sl. No	Name of region	Grasses	Legumes
1.	Western Rajasthan, South-East Punjab, Western Gujarat including Kutch and Western Saurashtra	<i>Cenchrus ciliaris</i> , <i>C. setigerus</i> , <i>Dichanthium annulatum</i> , <i>Lasiurus indicus</i> , <i>Panicum antidotale</i> etc.	<i>Atylosia scarabaeoides</i> , <i>Lablab purpureus</i> , <i>Macroptilium atropurpureum</i> , <i>Rhynchoisa minima</i> etc.
2.	Central Punjab, Eastern Rajasthan, Western Uttar Pradesh, Northern Gujarat, Maharashtra, Western Madhya Pradesh, Andhra Pradesh, Tamil Nadu and Karnataka	<i>Axonopus compressus</i> , <i>Cenchrus ciliaris</i> , <i>C. setigerus</i> , <i>Dichanthium annulatum</i> , <i>Heteropogon contortus</i> , <i>Panicum antidotale</i> , <i>Pennisetum pedicellatum</i> , <i>Sehima nervosum</i> etc.	<i>Atylosia scarabaeoides</i> , <i>Clitoria ternatea</i> , <i>Lablab purpureum</i> , <i>Macroptilium atropurpureum</i> , <i>Mucuna deeringiana</i> , <i>Stylosanthes hamata</i> , <i>S. scabra</i> , <i>S. viscosa</i> etc.
3.	Central and Eastern Uttar Pradesh, Southern Bihar, Southern Gujarat, Coastal Andhra Pradesh and Coastal Tamil Nadu	<i>Brachiaria mutica</i> , <i>Cenchrus ciliaris</i> , <i>Cynodon dactylon</i> , <i>Dichanthium annulatum</i> , <i>Panicum antidotale</i> , <i>P. maximum</i> , <i>Paspalum notatum</i> , <i>Pennisetum pedicellatum</i> , <i>P. polystachyon</i> , <i>Setaria sphacelata</i> etc.	<i>Macroptilium atropurpureum</i> , <i>Centrosema pubescens</i> , <i>Glycine javanica</i> , <i>Lablab purpureus</i> , <i>Mucuna deeringiana</i> , <i>Pueraria phaseoloides</i> , <i>Stylosanthes guianensis</i>
4.	West Bengal, Assam, Orissa, Eastern Madhya Pradesh and Kenkan	<i>Brachiaria brizantha</i> , <i>B. mutica</i> , <i>Cynodon dactylon</i> , <i>Dichanthium annulatum</i> , <i>Panicum maximum</i> , <i>Pennisetum clandestinum</i> , <i>P. pedicellatum</i> , <i>Setaria sphacelata</i> , <i>Urochloa mosambicensis</i> etc.	<i>Calopogonium mucoroides</i> , <i>Centrosema pubescens</i> , <i>Desmodium spp.</i> , <i>Stylosanthes guianensis</i> , <i>Vigna umbellata</i> etc.
5.	Lower hills of Punjab Himachal Pradesh, Uttar Pradesh and West Bengal	<i>Arundinella sp.</i> , <i>Chrysopogon fulvus</i> , <i>Dichanthium annulatum</i> , <i>Pennisetum pedicellatum</i> , <i>Themeda sp.</i>	<i>Atylosia scarabaeoides</i> , <i>Lablab purpureus</i> , <i>Macroptilium atropurpureum</i> , <i>Stylosanthes hamata</i> , <i>S. humilis</i> , <i>S. scabra</i> etc.
6.	High hills of Uttar Pradesh, Himachal Pradesh, Punjab and Jammu & Kashmir	<i>Bromus uniloides</i> , <i>Dactylis glomerata</i> , <i>Festuca arundinacea</i> , <i>Lolium perenne</i> etc.	<i>Lespedeza cuneata</i> , <i>Medicago sativa</i> , <i>Trifolium pratense</i> , <i>T. repens</i> etc.
7.	Valleys of Uttar Pradesh, Madhya Pradesh, Gujarat and Bihar	<i>Axonopus affinis</i> , <i>A. compressus</i> , <i>C. fulvus</i> , <i>C. ciliaris</i> , <i>D. annulatum</i> , <i>P. pedicellatum</i> etc.	<i>Lablab purpureus</i> , <i>Macroptilium atropurpureum</i> , <i>Mucuna deeringiana</i> , <i>P. phaseoloides</i> , etc.
8.	Usar (saline and alkaline) areas of Punjab, Haryana, Uttar Pradesh, Rajasthan and Gujarat	<i>Brachiaria mutica</i> , <i>Bothriochloa pertusa</i> , <i>Chloris gyana</i> , <i>Cynodon dactylon</i> , <i>Dichanthium annulatum</i> , <i>Diplachne fusca</i> , <i>Iseilema laxum</i> , <i>P. maximum</i> , <i>S. sphacelata</i> , <i>Sporobolus manginulus</i> ,	<i>Alysicarpus rugosus</i> , <i>Desmenthus virgatus</i> , <i>Rhynchosia minima</i>
9.	In swampy areas	<i>Brachiaria mutica</i> , <i>Iseilema</i> , <i>laxum</i> etc.	<i>Lotononis bainisii</i> , <i>Sesbania bispinosa</i>



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