

Pasture grasses for hot arid region

and their production technology

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The economy of the Thar Desert of India is mixed farming-based, and livestock mainly depend upon the native rangelands for sustenance. In this zone, the fodder is always short in supply and a deficit of around 61% green and 17% dry fodder is evidenced even in normal rainfall years. Buffel grass, bird wood grass, sewan, gramna, murath and marvel grass are the main range species dominate in the arid region and classified as 'High Perennial Grasses' play important role in bridging gap between demand and supply of fodder. These grasses provide nutritive fodder at low cost, ameliorate soil-health and aid in soil conservation in addition to many intangible benefits. Agro-techniques were standardized for raising pastures, and high-yielding genotypes of range grasses were identified at CAZRI, Jodhpur. Through the intervention of improved agro-techniques, new pastures can be established and high forage yield can be obtained from existing ones.

Key words: Agro-techniques, Forage yield, Pastures, Perennial grasses, Varieties.



Fig. 1. Buffel grass *Cenchrus ciliaris* var. CAZRI 75



Fig. 2. Buffel grass *Cenchrus ciliaris* var. CAZRI Anjan 358

THE economy of the Thar desert of India is closely linked with the raising of livestock, which mainly depend upon the native rangelands for their nourishment. The arid zone of Rajasthan has about 30 million livestock (13 million ACU) which require about 40 million tonne green and 19 million tonne dry fodder every year. However, semi-starvation is a rule as shortage of around 61% green and 17% dry fodder is experienced even in normal rainfall years. The quality of available fodder is also not

up to the mark. In this tract, grazing of livestock is a common practice as about 40% of total area is available for grazing mainly for cows, sheep and goat, however, the availability of green fodder is restricted to monsoon and post-monsoon only, and during rest of the period livestock graze on dry grasses and crop residues available in cultivated, fallow and wastelands, and other grazing lands. Under such situation pasture grasses play significant role to ensure fodder availability. Buffel grass, bird wood

grass, *sewan*, gramna, murath and marvel grass are the major range species dominate in the arid region were classified as 'High Perennial Grasses'. These grasses were mostly rhizomatous and the rhizomes remain dormant during adverse climate and as soon as they get favourable environment they activate and regeneration is initiated. These grasses have many tangible and intangible benefits in the economy of arid zone. These grasses provided nutritive feed to the livestock at low

cost, ameliorate soil-health and aid in soil conservation. Previously established pastures can be utilized even after three weeks of effective rainfall, whereas mostly cultivated forages take 45 to 60 days after sowing/regeneration for utilization. The grasslands also provided habitat for a variety of fauna and endangered species of plants, many of which are traditional medicines. Due to frequent droughts and overgrazing, the productivity of natural grasslands in the region was steadily decreasing and about 80% of the grazing lands in western Rajasthan was estimated fodder production of < 300 kg/ha/year. In arid areas, the capacity of natural grasslands is 0.2 to 0.5 ACU/ha, which needs to be enhanced through improved technological interventions.

PROMISING PERENNIAL GRASSES OF ARID ZONE

(*Lasiurus sindicus*) Sewan

This species called as 'King of desert grasses', is one of the dominant species of *Dichanthium Cenchrus Lasiurus* type grass cover. It survives under extreme arid conditions of Rajasthan and gives high herbage yield. The grass is extremely drought resistant and thrives even in low rainfall regions receiving 100 to 300 mm rainfall annually and was moderate tolerance to salinity. It naturally grows on extensive areas in far west of Rajasthan desert. It comes well on sandy soils and dunes in low rainfall areas. It is highly nutritive and palatable for the livestock. Under natural conditions crude protein ranges from 5.9 to 6.7% but when cultivated and fertilized with NPK, it reached up to 15%. Three hectares of *L. sindicus* is sufficient to support one adult animal (cattle) throughout the year. From good condition grasslands 3.5 to 4.0 tonne/ha dry forage can be harvested during optimum rainfall year. At CAZRI, Jodhpur some genotypes yielded more than 4 tonne/ha dry matter in the sixth year of establishment.

Buffel grass

It (*Cenchrus ciliaris*) is a vigorous, deep-rooted C₄ perennial bunch grass

native to tropical and sub-tropical arid environments. Commonly known as 'dhaman grass' in Rajasthan and 'anjan grass' in other parts of India, is considered a drought-resistant species. It is adapted to a wide range of soil and climatic conditions and can be cultivated in areas receiving annual rainfall of between 150 and 1,250 mm. One of the best forage grasses for semi-arid areas in the sub-tropics and tropics, is palatable when young, and remains fairly palatable at maturity also. The data of a trial (between 2010 and 2015) conducted at Centralized Research Farm, CAZRI, Jodhpur showed that dry matter yield of 3.0 to 3.5 tonne/ha can be harvested from 2 to 3 cuts during *khari*f. Depending on the soil moisture, 3 to 4 cuts can be taken from August to April. Crude protein varies from 6 to 10% of dry matter.

Bird wood grass

A tufted perennial grass (*Cenchrus setigerus*) extremely tolerant to heat and drought and grows in areas of annual rainfall as low as 250 mm making it excellent for improvement of low rainfall grazing lands. It is palatable to all kinds of livestock and can be propagated through seeds. It can be used for renovating the denuded pastures or establishment of sown pasture. The grass is either grazed or cut and fed to livestock *ad lib.* or turned into hay. Palatability of this species is similar to *C. ciliaris*- 'very good'. Crude protein content of dry matter varies from 5 to 12%. In dry areas up to 15 tonne/ha green forage was recorded from rainfed sward from 3 harvests from July to October. Dry matter yield up to 4.9 tonne/ha were recorded during good rainfall years in arid region. The grass was suggested as a barrier against moving sand. Its response to winter rains is poor than *C. ciliaris*.

Karad

In Rajasthan the species (*Dichanthiummannulatum*) occurs mainly in the rainfall regions of > 350 mm. It evades or tolerates drought well. The plant grows to a height of 75 cm at maturity stage. It is regarded as an excellent fodder plant and highly valued pasture of

high quality, vigour and productivity. An average hay production of 3.3 tonne/ha can be expected from a good stand of the grass.

Blue panic

The species (*Panicum antidotale*) is often found on sand dunes and is an excellent sand binder. This drought resistant perennial grass is adapted to a variety of soils and climatic conditions. This productive grass can serve as a good source of fodder supply either as hay or silage. On the livestock farms of the tropical and sub-tropical countries this can be a good fodder source throughout the year because of its wider adaptability, persistency, high productivity and good seeding capacity. It can be either grazed or cut and fed to the livestock. The grass is highly nutritive when cut at pre-flowering stage as at this stage fodder have high crude protein (4.0 to 15.6% dry matter basis). It can yield 10 to 50 tonne/ha green fodder and hay production varying from 2.5 to 6 tonne/ha under rainfed conditions.

Murat

This grass (*Panicum turgidum*) is grown on sand dunes and sandy plains in open rangelands and cultivated fields of Thar desert in Rajasthan and Gujarat. A common and characteristic species, often playing an important role in colonizing shifting sand dunes. Green fodder productivity ranges from 5.0 to 7.5 tonne/ha with 2.0 to 3.0 tonne/ha dry matter. Although hard and woody, young stems serve as an excellent nutritive camel fodder. It has 59% dry matter at flowering and 4.9% crude protein.

Production technology

Pasture establishment is the conversion of seed or other propagating material into production returns. The routine pasture development practices as applied under higher and more reliable rainfall conditions are out of question in the arid and semi-arid regions in north-western India. Climatic conditions in these parts are too erratic and individual falls of rain are too ineffective for regular germination and continued early growth of grasses.

Introduction of new species is risky in the areas with <300 mm average annual rainfall. While selecting the species, priority should be given to indigenous species.

Following are the techniques, which may be adopted in getting higher production from pasturelands.

Selection of site

The land which is not utilized for cultivation of crops can be put under pasture establishment. Pastures grasses grow well on fertile land. The site should be free from salinity, alkalinity and waterlogging. It is advisable to take up pasture development work at sites with easy accessibility and water facility so that local people can visit the places frequently and realize the value of such development work.

Clearing land for planting

The principal aim of the farmers is to provide a favourable environment in which seeds germinate, seedlings emerge, grow and survive. Less palatable unwanted shrubs, bushes and other perennials should be hand cleared or mechanized method may be used, so that the competition for light, water and nutrients need to be reduced to a point where productive pastures can be established.

Land preparation

It depends to a large extent on available resources and method of planting. Fields are prepared like other field crops. One to two ploughings are needed to pulverise the soil and each ploughing should be followed by planking. Field preparation operations should be carried out as close as possible to the onset of summer ending and monsoon, to take the advantage of rains for the establishment phase.

Protection

Overgrazing, a characteristic problem in arid areas may result in complete deterioration of grazing land. Therefore, protection of the area is urgently required to minimize the losses caused by overgrazing. Angle iron posts with barbed wire are the most effective fence but the initial cost is high. Hence, ditch (1.25 m

wide and 1.00 m deep) on outside and core wall on inside may be constructed through 'shramdan' or participatory approach. Top feed species like *kummat* (*Acacia senegal*), Israeli *babool* (*A. tortilis*), *desi babool* (*Acacia penninertis* var. *cupressiformer*), *phog* (*Calligonum polygonoides*), *ker* (*Capparis decidua*), *baoni* (*A. jacquemontii*) etc. can be planted on the core wall. Simply by protection, pasture productivity can be increased by 2 to 3 times.

Choice of species

Agro-climatic conditions and edaphic factors affect the productivity of different grasses. For the areas with <300 mm rainfall and deep sandy soils *L. indicus* is the only choice. On sandy loam soils *Cenchrus* species were recommended. In the areas having >300 mm rainfall, *C. ciliaris*, *C. setigerus*, *P. antidotale* and *P. turgidum* grasses were recommended. In heavier soils of the higher rainfall zone (>380 mm annually), *D. annulatum* and *Cenchrus* species were found suitable.

Improved varieties for hot arid region

CAZRI 75 (*Marwar Anjan*): A variety of *Cenchrus ciliaris*, selected from exotic collection no. 14369 (Australia) was released by CAZRI in 1995. Erect growth habit with medium plant height, long, broad, droopy and green leaves and actively growing. The yield potential is 2.8 tonne/ha dry matter and 8.8 tonne/ha green fodder.

CAZRI 76 (*Marwar dhaman*): A variety of *C. setigerus*, selected from exotic collection no. 17655 (Australia) was released in 1985 by CAZRI. Semi-erect growth habit, 50 to 60 cm tall plant, leaves are medium-narrow, long, yellowish green and semi-erect, nodal pigmentation is brown and slow senescence. Green fodder yield is 5.85 tonne/ha, much relished by small ruminants.

CAZRI *Anjan* 2178: This variety of *C. ciliaris* with high forage production contains 5.1% crude protein. On an average its green fodder yield was 10.8 tonne/ha, 15 to 33% more than the yield of checks CAZRI 75 (9.4 tonne/ha) and IGFR 3108 (8.1 tonne/ha). It also

yielded high dry matter yield (3.8 tonne/ha) which was 82% more than IGFR 3108 (2.1 tonne/ha). Plant height was more than CAZRI 75 and slightly less than IGFR 3108.

CAZRI *Anjan* 358: At Jodhpur, on an average the green fodder yield of the variety was 8.4 tonne/ha which was 35.9% higher than the yield of check CAZRI 75 (6.2 tonne/ha). It also yielded high dry matter yield (2.0 tonne/ha), 10.5% more than CAZRI 75 (1.8 tonne/ha). In seed trial, the variety produced 266 kg/ha, which was 179.1% more than the check CAZRI 75 (95.3 kg/ha) and 518.6% more than the check IGFR 3108 (43.0 kg/ha). Its plants attain a height of 100 cm.

CAZRI *Sewan* 1: The average productivity of the variety is 15.7 tonne/ha green fodder yield, 5.7 tonne/ha dry matter yield, 229 kg/ha/day green fodder and 86 kg/ha/day dry matter. Plants of the variety attain a height of 110 cm.

Fertilizer

To get the optimum fodder of quality, it is essential to provide adequate nutrients to the pasture. Application of nitrogen @ 40 kg/ha and phosphorus @ 20 kg/ha is recommended to get good growth of grasses. Full dose of phosphorus (P) and half dose of nitrogen (N) should be given as basal dose. Remaining dose of the nitrogen should be given at the tillering.

Seeding rate

Seed rate depends on the quality of seed, climate, seed-bed type, weed problem and method of seeding. Success of the pasture is directly attributable to quality of the seed. With low quality seed larger amounts will be necessary. Seed rates are thus based on purity and germination percentages. More seeds per unit area can be used in the high rainfall zone to provide a faster cover thus checking weed growth. Denser seeding rates are recommended on roughly prepared seedbeds. Where heavy weed infestation is expected because of different causes the seeding rate should be increased accordingly, and wherever seed is broadcast the seed amount should be

increased up to 50%. All pasture seeds were small and those of the perennial grasses were light. Seed rates were low, but the seed is expensive; utmost care should be taken while sowing. The seed rate for grasses vary considerably, however, the seed requirement for 1 ha is 6-7 kg for *L. indicus*, 5-6 kg for *C. ciliaris* and *C. setigerus*, 2 to 3 kg for *D. annulatum*, *P. antidotale* and *P. turgidum*.

Sowing time

The sowing time is central to the success, durability and production of a pasture. It differs significantly with local environments and farming systems. The sowing is done when soil moisture and temperature are appropriately high to permit rapid germination and establishment. Tropical perennial grasses of arid zone were sown after first effective showers of monsoon (from last week of June to July). Better results were obtained when sowing is done in mid- of July.

Sowing method

Through seeds: Seeds of pasture grasses were light and generally not free-flowing thus sowing through seed drills was not a good proposition as it may lead to uneven distribution of seeds resulting in more seed requirement. Therefore, the best way is to mix the seeds with wet field soil in 1:5 ratio (by volume). This seed mixture is placed in open furrows manually after effective showers of monsoon.

Line-sowing is preferred as it makes the after sowing operations easy. Pasture seed is costly and at times difficult to obtain, therefore utmost care should be taken to obtain a good sward.

Vegetative propagation: Arid zone grasses were planted through vegetative propagation. Land preparation was similar to that for seed sowing, but the final tilth need not be so fine. Rooted slips/newly raised seedlings were planted at the onset of monsoon. These should not be planted during very low and high temperatures. Two to three seedlings were placed in a hill. Utmost care was taken not to dry out the planting

Table 1. Forage yield (kg/ha) in *Cenchrus ciliaris* with different spacing

Row spacing	Green forage yield					Dry matter yield				
	2005	2006	2007	2008	Mean	2005	2006	2007	2008	Mean
50 cm	4,696	10,745	4,008	2,731	5,546	1,526	2,522	1,883	1,654	1,896
75 cm	4,465	10,122	3,689	2,747	5,256	1,513	2,422	1,745	1,696	1,844

material. For better establishment water was must at the plantation. After planting, watering was also required at 2 to 3 times. In hot arid zone vegetative propagation was a costlier proposition and results were not up to the desired level. It work for smaller areas but for larger areas seed sowing was the best proposition.

Sowing depth

Sowing depth is decided by the size of the seed and smaller the size lesser the sowing depth. The caryopsis in tropical grasses was very small, therefore, seeds were not sown deep otherwise seedlings would fail to emerge at the surface. Seeds of the desert grasses showed optimum germination under field conditions when sown at shallow depth of 1 to 2 cm with a light soil cover.

Spacing

Cenchrus ciliaris, *C. setigerus* and *D. annulatum* with 50 to 75 cm row-to-row spacing proved best for optimum forage production in arid zone. *L. indicus*, *P. antidotale* and *P. turgidum* exhibit more radial expansion, therefore row-to-row spacing for these grasses varied from 75 to 100 cm depending upon soil types and rainfall conditions. In the areas receiving <300 mm rainfall annually the upper limit was advocated. In *C. ciliaris*, mean fodder production of four years (2005 to 2008) was 5,256 kg/ha green and 1,844 kg/ha dry from 75 cm row spacing and these values were at par with 50 cm spacing (5,546 kg/ha green and 1,896 kg/ha dry), Table 1. Closer spacing had no added advantage; hence 75 cm row spacing was found ideal for fodder production in *C. ciliaris* under arid climate.

Weeding

Removal of weeds from the seeded pastures should be done after 3 to 4 weeks of sowing for better establishment and production of

pastures. *Dhaman* grasses and *sewan* recorded about 100% increase in forage yield by weeding alone. One weeding is essentially required in the year of establishment, thereafter, may be done as per need.

Utilization of pasture

Scientific utilization enhanced the productivity and longevity of the pasture land.

Pasture can be utilized by following methods:

Cut and carry method: Cutting at right stage is basic for good regrowth of the sward. In a normal rainfall year two-to-three cuts can be taken, if harvested at 50 % flowering. To avoid trampling damage during the establishment stage, it is advisable to guard pasture from grazing animals. In the establishment year, excess grass may be harvested and conserved as hay for utilization during lean period. Higher production of pasture starts from the second year of establishment; hence utilization of pasture in rational way is advocated for effective maintenance of regeneration in subsequent years.

Grazing: Suitable grazing system enhances the longevity of the sward. In arid areas, most of the perennial grasses attain a height of about 1 m, except few like *P. antidotale*, grazing should begin at flower initiation to 50% flowering stage and it should be discontinued to the stubble height of 10 to 12 cm. To harness the maximum productivity of pasture lands, controlled grazing based on carrying capacity is the best way. The carrying capacity of excellent condition pastures is 25 to 30 ACU/ 100 ha in arid zone in normal rainfall year. Grazing saves cost of harvesting of low set grasses and also livestock while grazing work up the soils through their hooves, breakup the upper crust of the soil, thereby, boosting better percolation of water for plant use and better grass productivity. Over grazing should be

avoided as it may harm the pasture and it also invites annual weeds.

Hay making: In the good rainfall years, the forage yield from excellent class pastures is fairly high, it is better to reserve about 25% portion of pasture to harvest during flowering stage and preserve it as 'hay' for feeding down calves, milking stock, suckling, sick animals, working bullocks and all stocks during adverse climatic conditions. Fodder banks can be created at least at *Panchayat Samiti* level for proper utilization of community pasture.

Forage yield

Production of pasture lands depends on climate, soil type and management. In a good rainfall year, the average dry matter productivity of *C. ciliaris*, *C. setigerus*, *L. indicus*, *P. antidotale*, *P. turgidum* and *D. annulatum* is 3.0-3.5, 2.0-2.5, 3.5-4.0, 2.5-6.0, 2.0-3.0 and 3.3 tonne/ha, respectively. The peak forage production from the pastures of *Cenchrus* species was seen in 3rd and 4th year and it starts declining after 5th year. Rejuvenation of pastures hence needs to be undertaken after 5 or 6 years. *Lasiurus indicus* pastures remain productive for decades with controlled grazing.

Seed production

Pasture seed is a rare commodity, not easily available in the open market and expensive. Therefore, some alternate arrangement at the farm was made. To meet the recurring demand of pasture seed, 1/10th area of the pasture was utilized for seed production. Improved techniques to harvest high seed yield of quality was employed. Some of these were:

Cutting management for seed yield and its quality in *C. ciliaris*: Different cutting management practices i.e. control (uncut), single cut at 30 day and 45 day of sowing/regeneration and at 50% flowering were given to three genotypes between 2010 and 2013 under arid climate. The uncut crop produced maximum pure seed yield during all the years and average yield of the second, third and fourth year was 86.3 kg/ha, which was 117.4, 283.6 and 119.0% higher than the crops cut on 30 day, 45 day

and 50% flowering, respectively. Higher seed yields were obtained in the uncut crop hence fodder cutting is not advisable for enhanced seed yield under hot arid climate.

Spike harvesting in *C. ciliaris*: In *C. ciliaris*, seeds were harvested both from primary and secondary spikes for quality seed production. Although the quality and quantity of seeds of primary spikes were higher than the secondary spikes but the seed quantity from latter contributed significantly to total yield. Germination of seeds of both types of spikes was at par with the IMSCS (30%).

Seed harvesting method in *L. indicus*: To maximize seed yield, seed harvesting by following 'hand cutting seed heads' at 1 to 2 upper seed ripe stage was found better than hand picking of seeds. Mean values of three years were 138.6 kg/ha for pure seed yield and 32.8% for seed germination with this method. In *L. indicus* ripe seeds fall on the ground rapidly resulting in colossal seed loss. Collection of few seeds/individual seed as per maturity is very expensive and more rounds are required to collect all the seeds from a spike. Hand cutting seed heads' (modified method) is less labour intensive with reduced seed loss and recommended for this pasture species.

Maintenance of pasture

In the arid zone maintenance of established pasture is very cumbersome task because the environment is very hostile and over grazing is a common problem as the area is drought prone and heavily populated. Sowing of grasses in the abandoned and weed infested area often leads to disappoint pasture establishment. Removal of weeds before seeding and subsequent weeding after sowing of grass seed would guarantee better establishment of pasture and forage production. Removal of weeds 3-4 weeks after germination is essential during the year of propagation. Interculture operations by tractor drawn cultivator were required for better aeration and improvement of soil structure. This provides good environment for adventitious root development ultimately resulting in increased

pasture productivity. Over grazing invites annual grasses and weeds hence controlled grazing as per carrying capacity is the best way to utilize the pasture for productivity, and longevity of the pasture. That should be well protected from stray animals and illicit grazing should be completely checked. If utilized through cut and carry system, cutting should be at right stage, i.e. at 50 % flowering of the stand. The remnant portion of grasses should also be removed before the start of dormant period. Reseeding should be done when the productivity starts declining.

Cost of cultivation

Pasture cultivation is costlier at establishment, which varied from ₹ 12,000 to 15,000/ha. In the upcoming years the cost of production reduces, whereas pasture production increases resulting in increased profit. Second year onwards with 3,000 kg/ha dry matter production, the expected net profit comes from ₹ 6,000 to 7,000. Intangible benefits from the pasture land include improvement in environment, development of dairy industry, conservation of biodiversity and employment generation.

SUMMARY

The economy of the farmers of the Thar desert is mainly dependent on mixed-farming. The fodder is mostly shortage in supply as the prevailing biotic and abiotic factors exert pressure on biomass production. In this situation perennial grasses, viz. buffel grass, bird wood grass, sewan, gramna, murath and marvel grass which produce high forage yields can support the animal-based farming system in arid zone. Range grasses of arid zone and their cultivation practices, viz. selection of site, field preparation, protection, choice of species, improved varieties, fertilizer application, sowing time, sowing method, seeding rate, weeding utilization of pasture, yield potential, seed production and maintenance of pasture discussed in this article will aid in pasture establishment in arid zone.

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