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Cenchrus ciliaris and *Stylosanthes seabrana* for grassland development in semi-arid areas of Maharashtra

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Introduction

A high proportion of grazing lands on the semi-arid Deccan plateau of Maharashtra, India are severely degraded and have experienced considerable loss of perennial vegetation and soil due to erosion. Consequently, these grazing lands have very low levels of pasture and animal productivity, water use efficiency is low and in combination these factors are threatening grazing systems of the local shepherd community. In Maharashtra 42% of the land is either covered with forest or scrub vegetation or left as culturable wasteland. Much of the efforts in land management have been directed towards forestry land with little attention given to private lands. These efforts have been directed largely to the establishment of trees or pasture as an aid to reduce soil erosion and not to increase available fodder resources. The failure to address the causes of land degradation on private lands has contributed to the marginalization of the pastoralist communities. The threats to pastoralism coincide with a sharp increase in the demand for animal protein, which is expected to continue in future. Current production of small ruminants in India will not be able to meet this increased demand and attempts to increase production from existing systems will accelerate land and water degradation. For grassland production and utilization each of the components *viz.* soil, plants, animals and humans is equally important. Grassland development can potentially increase soil organic carbon which in turn has a potential to offset greenhouse gas emissions (Lal, 2004) and benefit soil ecosystems (Whitbread *et al*., 1998). Increased fodder production will be beneficial to both the animals and humans. The two plant species which are the most suited for conservation of and improving the productivity of rangelands in Maharashtra are Stylosanthes and Cenchrus. The legume Stylosanthes establishes well on poor and severely eroded soils under dryland conditions. According to Mohamed-Saleem (1994) its ability to improve soil bulk density, infiltration rate and water holding capacity makes it a useful species for the conservation, stabilization and sustainable development of land and water resources. According to Pathak *et al*., (2004) Stylosanthes seabrana (Caatinga stylo) with enhanced adaptation is expected to increase the potential areas and prospects for the use of stylo in India. It being adapted to heavier-textured soils has a potential for incorporation into farming systems on better cropping soils in addition to integration into pastures (Hall and Glatzle, 2004). The use of S. seabrana for wasteland and watershed development as well as in large-scale plantation and forestry projects can help develop a large seed industry. *Cenchrus ciliaris* (buffel grass) is a versatile and diverse grass species, which is fairly easy to establish. *C. ciliaris* is native to India and for many centuries has been the predominant plant species in "Korangadu" – the traditional pastureland farming system existing in the semi-arid tract of Tamil Nadu state in South India. *C. ciliaris* often occurs in the wild on sandy soils, but is also well-adapted to deep, freely draining sandy loam, loam, clay loam and red earth soils. Being most drought-tolerant of the commonly sown grasses, *C. ciliaris* occurs naturally in areas with average annual rainfall from as low as 100 mm up to about 1000 mm, but most commonly between 300 and 750 mm.

Materials and Methods

Preliminary screening of 12 accessions of *C. ciliaris* sown in an unreplicated trial in the nursery at the Nimbkar Agricultural Research Institute was carried out in 2012-13. The soil was shallow with pH 7.9, electrical conductivity 0.62 dS m^{-1}, organic carbon 0.48%, available nitrogen 159 kg ha^{-1}, available phosphorus 35 kg ha^{-1} and available potassium 349 kg ha^{-1}. It was given nine flood irrigations and four weeding. Inorganic fertilizers were applied to give 80 kg ha^{-1} each of nitrogen and phosphorus. Harvesting was carried out five months after sowing. The four accessions giving the highest fresh biomass production were selected for a large-scale trial.

A typical, heavily eroded 1.37 ha area near village Vinchurni was selected for the trial. In July 2013 after the monsoon had set in, it was divided into four parts. One kg seed each of the four most promising accessions identified in the nursery evaluation was broadcast into separate plots behind a bullock-drawn harrow. The average soil depth at this location near Vinchurni village is 23 cm with soil analysis giving values of 8.33, 0.53 dS m^{-1}, 0.42%, 100.6 kg ha^{-1}, 14.8 kg ha^{-1}, 175.4 kg ha^{-1}, 1.36 meq l^{-1} and 5.47% for pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus, available potassium, free sodium and free calcium respectively. The area was fenced to prevent grazing. The rainfall

received was 250 mm in June 2013, 525 mm from July-December 2013 and 425 mm in 2014. Due to the severe drought conditions in 2014 farmers had to leave the surrounding rainfed areas uncropped. During 2014 monsoon 36 Kg of *S. seabrana* seed was broadcast into the plots. In December 2014 four areas of 20 m^2 each were harvested from each plot for evaluation.

Results and Discussion

In the nursery evaluation cultivar 'Laredo' was found to be the best, yielding 15.4 t ha^{-1} fresh weight and 5.6 t ha^{-1} dry weight in five months. 'Laredo' (Plate 1) was released in the USA in the year 2000 by Pogue Agri Partners Inc. in Texas and is a mixture of several lines. It is said to perform equally well on sandy soils and heavy soils with good drainage. It was developed for increased forage production with the added advantage of blight tolerance. It was followed by the so-called *Cenchrus* hybrid obtained from the Central Sheep and Wool Research Institute in Avikanagar (Rajasthan), 'CAZRI-75' obtained from Central Arid Zone Research Institute in Jodhpur (Rajasthan) and 'Gayndah' from Australia.

The estimated grass coverage in the rainfed trial was 25-30% with average fresh and dry biomass weights for the best entry 'Laredo' of 3.2 and 1.8 t ha^{-1} respectively. With full grass coverage 10-12 t ha^{-1} fresh weight and 5-7 t ha^{-1} dry weight can be expected from 'Laredo' in 17 months without any inputs.

Plate 1: Three month-old 'Laredo' (October 2013)

Plate 2: Fourteen month-old 'Laredo' (September 2014)

After the rainfall in July-August 2014 many new seedlings were observed to have emerged from the previous year's seed which had fallen on the ground (Plate 2). Similarly, observations in March 2015 showed a lot of plants of *S. seabrana* which had emerged. This in addition to increasing the soil coverage should also improve the value of the fodder.

Conclusion

It is necessary to develop sustainable land management systems in India to meet the ever increasing demand for animal protein and solve the problem of land degradation. As shown by this study introduction of fodder species like *Cenchrus* and *Stylosanthes* could be one of its main components. Preliminary evaluation trials confirm the high potential of these species even on highly eroded poor soils under rainfed conditions where no other crop can be profitably grown. The 3 t ha^{-1} fresh biomass weight obtained in one and a half year with about 25% ground coverage can be increased many fold with the supply of nutrients through fertilizer application.

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