THEME:
AGROFORESTRY AND FARMERS INCOME

Title of the technology

Prosopis cineraria based agroforestry for hot arid region of Gujarat and Rajasthan

A: Nature of technology

Agroforestry model for agriculture land

B: Process in brief

The increasing demand of fodder and fuel wood as a function of increasing human as well as livestock population in the region emphasized the need of more diversified production system. However, forest cover in the dry areas is very poor and therefore emphasis is laid on integrating trees in agricultural land to intensify the traditional production system and to meet the increasing multiple demands. This study on the effect of varying regimes of *Prosopis cineraria* (khezri) and *Tecomella undulata* (rohida) and the soil plant interaction was initiated in 1991 with 1666, 833 and 417 stem ha^{-1} of *P. cineraria* and different agricultural crops. Five-year-old plantations of *P. cineraria* and *T. undulata* were thinned in June, 1995 to reduce tree density from 1666 tree ha^{-1}, 833 tree ha^{-1} and 417 trees ha^{-1} to obtain tree spacing of 4 m x 6 m, 4 m x 9 m and 8 m x 6 m with tree densities of 417 tree ha^{-1}, 278 tree ha^{-1} and 208 tree ha^{-1}, respectively. Due to reduction in crop yield, the stands were further thinned to obtain tree spacing of 8 m x 6 m, 8 m x 9 m and 8 m x 12 m in June, 2002, respectively, which gave tree densities of 208, 138 and 104 trees ha^{-1}. Because of general practice of crop rotation, the intercrops grown were *Vigna mungo* (L.) (mungbean) in 1999, 2000 and 2003 (Fig. 1) and *Pennisetum glaucum* (L) R. Br. (pearlmillet) in 2001. Crops were sown and harvested in rainy season (July to October) and rainfed condition. Two weeding were provided to the agricultural crops for proper growth and flowering/fruiting.

Tree size, competition for resources at high densities and soil water deficit as a result of increase solar radiation at low tree density were the probable factors affecting crop production. Outputs of crop yield and tree growth and biomass suggested that optimum tree density, which provided highest crop production decreased with tree size/ age i.e., 417 trees ha^{-1} (4 m x 6 m), 278 trees ha^{-1} (4 m x 9 m) at 6 and 7 years, 208 trees ha^{-1} (8 m x 6 m) at 10 year and less than 208 trees ha^{-1} at 11 year of age and above. The result indicated bio-economic benefits of optimum tree density of traditional practices of integrating trees in farming system in arid zones.

C. Beneficiaries of the technology

1. Prominent beneficiaries/user groups: Farmers and State Forest Departments of Rajasthan and Gujarat, and non-government organization.

Fig. 1. Stand of *P. cineraria* in traditional agroforestry (left), and at AFRI experimental area associated with *Vigna radiata* as the intercrop in the Year 2003 (right).

2. No. of clients to whom technology has been transferred

Ministry of Rural Development helped in funding. Farmers of the region are the main beneficiaries to whom this technology was demonstrated through field visits of the area. This technology has been discussed at many forums such as workshop/conferences, meeting/ stackholder, public forum etc.

3. Potential for further dissemination

Currently, density of *P. cineraria* ranges from 3 trees ha^{-1} in northwestern to more than 80 trees ha^{-1} in northeastern part of Indian desert. However, a density of *P. cineraria* trees > 150 ha^{-1} has also been observed in some cultivated fields in the Indian Thar desert. But considering an average of only 1.27 % forest cover in the arid region of western Rajasthan, tree cover must be increased on agricultural fields. Growing trees at higher densities would be the best options to increase overall productivity of the farmland and to fulfill the increasing demand for fodder and fuel wood as a consequence of increasing population. Selection of tree species suitable for integration in agriculture land is more important and *P. cineraria* is one of the best species for this purpose. Further, *P. cineraria* is protected and maintained on farmer's field for ages because of its multipurpose uses, soil fertility enhancing ability and symbiotic effect on the associated agriculture crop. The tree is lopped heavily in the onset of winter season, which helps the winter crop. Following papers have been published for wide dissemination of the knowledge. Promotion

of this practice may have immense impact to increase population of tree outside forests and for local benefits;

1. G. N. Gupta, G. Singh and G. R. Kachwaha (1998). Performance of *Prosopis cineraria* and associated crops under varying spacing regimes. *Agrofor. Systems*, 40: 149-157.
2. G. Singh, S. Mutha and N. Bala (2007). Growth and productivity of *Prosopis cineraria* based agroforestry system at varying spacing regimes in the arid zone of India. *J. Arid Environment*, 70(1): 152-163.
3. G. Singh (2009). Comparative productivity of *Prosopis cineraria* and *Tecomella undulata* based agroforestry systems in degraded lands of Indian Desert. *Journal of Forestry Research*, 20(2): 144-150.

D. Economic significance

1. Potential to address livelihood issues and generate additional income

Agroforestry systems are now recognized and become prevalent in the hot arid region for the ecological and socioeconomic benefits including products for household and national economics like food, fodder and medicine. Trees integrated extensively in the crop and livestock production systems are *Prosopis cineraria, Tecomella undulata, Acacia nilotica, Acacia tortilis* and *Ailanthus excelsa*. Trees in agroforestry systems use water from soil that shallower plant roots cannot access. *P. cineraria* enhances productivity of soil and the associated crops and provides fruit and leaf for vegetables and fodder, respectively. The crops are grown in the interspaces of the trees. It provides valuable fodder for cattle and fire wood for domestic use (from the lopped material). The tender pods of *P. cineraria* are used as vegetable and are the major ingredient of "Panchkuta"- a local delicacy.

2. Productivity enhancement and economic benefits over replaced technology

In general people of Indian desert does not plant *P. cineraria* plants on their farmland rather protect and take care of randomly growing tree or seedlings regenerated on their farmlands. Maintaining optimum densities of 833 tree ha^{-1} at 2-3 years, 417 tree ha^{-1} at 4-6 years of age, 278 trees ha^{-1} at 6-7 and 7 years, 208 trees ha^{-1} at 11 year and <208 trees ha^{-1} at 12 years of age or above increased crop yields by 10-15% as compared to the sole crop without tree. The result indicated bio-economic benefits of optimum tree density of traditional practices of integrating trees in farming system in arid zones. In addition, *P. cineraria* provides fruit of 350 –1040 g $tree^{-1}$ used as vegetable. In addition, *P. cineraria* provides utilizable biomass of 19.96 tones ha^{-1} including leaf fodder of 0.85 tones ha^{-1} per year at 12 year age (208 tree ha^{-1}).

Types of benefits associated with this practice

Environmental	Economic	Social
Increase in soil status and production per unit area.	Increased landscape value.	Improvement in social status.
Increase in carbon stock both in soil and tree.	Increased fuel wood supply.	Reduced time in fuel wood collection and diversion of children to education.
Tree integration reduces land degradation and conserves the natural resource improving biodiversity.	Increased agricultural production and land value.	Improvement in education and health.
Increased production of fodder and fuelwood as *P. cineraria* provides utilizable biomass of 19.96 tones ha^{-1} including leaf fodder of 0.85 tones ha^{-1} per year at 12 year age (208 tree ha^{-1}).	Increased income through fodder and fuelwood.	Increased income facilitates social status and promotes education.

3. Impact of the Technology

In addition to increased agriculture production at optimum density *P. cineraria* provides utilizable biomass of 19.96 tones ha^{-1} including leaf fodder of 0.85 tones ha^{-1} per year at 12 year age. Legumes are more suitable than *Penisetum glaucum* (pearlmillet). Pearlmillet was found more competitive with tree than *V. radiata* (mungbean) as observed through reduced tree growth increment when pearlmillet was the intercrop. Yield of agricultural crop increased when density of *P. cineraria* was appropriate (i.e., optimum tree density), which varied with tree size/age because of competition for soil resources. Agroforestry is more beneficial than sole agricultural crop in term of carbon benefits also. *P. cineraria* are the best species and are less competitive with crop as compared to the other tree species. Optimum density observed through field trial in agroforestry system was also introduced in Western Rajasthan through Maru gauchar Yojana.

E. Technology developed by {Name of Scientist(s)/officers(s)}

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