AGROFORESTRY RESEARCH FOR SUSTAINABLE PRODUCTION IN ARID AND SEMI ARID REGIONS OF RAJASTHAN

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Indian arid zone is characterized by hostile climatic conditions i.e., low and erratic rainfall and intense solar radiation coupled with high wind velocity. Recurring drought and famines are common features of the region. Farmers deliberately integrate trees in their farmlands since ages as strategies to overcome the problem of natural calamities. The farmers maintain and promote the trees like *P. cineraria*, *Tecomella undulata* and *Ziziphus nummularia* on farmland that helps the farmer to sustain during the crop failure by providing food, fodder, fuelwood and timber. Afforestation of agriculture land creates more integrated, diverse, productive, profitable, healthy, and sustainable land-use systems. 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.

Some of the important models on integrating forestry and horticultural species in the agricultural lands to intensify the production systems are linear forest; plantations; forestry species in combination of animals, grass or agriculture and includes fruit trees, timber production, silvopastoral and silvi-agriculture; and woodland/ wood lots. Some of the experimental evidences which showed the benefits of tree integration in agriculture lands are highlighted here. In general *Prosopis cineraria*, *Tecomella undulata*, *Emblica officinalis*, *Hardwickia binata* and *Colophospermum mopane* tree species were tested with various agricultural crops like were *Vigna radiata*, *Pennesetum glaucum*, *Sesamum indicum*, *Cymopsis tetragonoloba* and *Cassia angustifolia*.

Some significant findings of agroforestry experiments in arid zone of Rajasthan are:

- *P. cineraria* is best species for the agroforestry. It was found less competitive than *T. undulata* for agricultural production.
- Crop yield reduced when agricultural crop was integrated with trees at the density of 4 × 6 m spacing.
- Crop yield was 7-15% less under *T. undulta* than under *P. cineraria* based agroforestry. However, it can be compensated by timber value if a farmer wants to integrate *T. undulata* than *P. cineraria* in the agriculture field.
- Legumes are more suitable than *Penisetum glaucum* (pearlmillet), which was found more competitive with tree than mungbean as observed through reduced tree growth increment when pearlmillet was the intercrop.

- Production of utilizable biomass was 21-32 tones ha^{-1} for *P. cineraria* and 17-30 tones ha^{-1} for *T. undulata* at 8 year of age (at a spacing of 4 x 3 m).
- Crop yield reduced both at high and low tree density and increased with distance from tree base for all species under test.
- Optimum density was 833 at 2-3 years, 417 at 4-6 years, 278 at 7-8 years and 208 trees ha^{-1} at 9-11 years of tree age.
- Fruit yield of *P. cineraria* ranges from 350 –1040 g per tree at the age of 7-8years.
- *P. cineraria* provides utilizable biomass of 19.96 tones ha^{-1} including leaf fodder of 0.85 tones ha^{-1} at 12 year age (208 tree ha^{-1}).
- *C. mopane* produces 3.0-4.0 kg dry fodder/ fuel wood per tree per year at 7-8 year age, whereas fruit production was 0.5 kg tree^{-1} at 5 to 1.25 kg tree^{-1} at 9 year age. Fruit production reduced bajra or guar were the intercrops.
- *C. mopane* extracts more soil water compared to *H. binata* and *E. officinalis* and seems to be more competitive with companion agriculture crops.
- Loss in SOC is less (3.2 to 35%) in agroforestry plots compared to that in control plot (56%). Thus agroforestry is more beneficial than sole agricultural crop in term of soil carbon accumulation.

Recommendations

P. cineraria and *T. undulata* could be grown at 208 tree ha^{-1} up to 12 years without significant reduction in agricultural production. Outputs from the trees are the additional benefits. *C. mopane* is more suitable for rehabilitation of degraded lands than its integration with agricultural crops because *C. mopane* can be raised under site preparation and direct seeding. Competition of trees is less during dry period than in good rainfall year. Hence, beneficial effects of trees are greater when environmental conditions are more adverse than in the normal conditions both in terms of environmental benefits and economic benefits.

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