

could find place in every farming system of the region as an agroforestry component without any constraints. However, over time, productivity of trees started declining because of aging, poor orchard management, biotic stress, old seedling plantation etc. An attempt has been made at CAZRI Jodhpur, Rajasthan, India to rejuvenate a 33-year-old *ber* orchard. Trees were headed back from ground level in June 2011. Numerous shoots emerged after 12-15 days. 1-2 shoots were budded with early, mid and late season's cultivar Gola, Seb and Umran, respectively. In the next year, intercropping was carried out in the *ber* alleys. The treatments consisted of two intercrops with *ber* viz. greengram and pearl millet, two alleys spacing i.e. 6 m and 12 m (plant to plant spacing in both the alleys was 6 m) tested over three *ber* varieties viz. Gola, Seb and Umran.

During the second year, average fruit yield of rejuvenated *ber* under 6m x 6m spacing + greengram was 47.6% higher over 12x6 m spacing of *ber* + greengram while under pearl millet the yield increment for *ber* was 46.5% with respective yield of 11.4 and 9.5 kg tree⁻¹. Contrarily, the yield of intercrops of greengram (31.1%) and pearl millet (11.0%) was higher under 12m x 6 m spacing with respective yields of 666 kg and 556 kg ha⁻¹ under 6m x 6m spacing. Total system productivity was recorded highest (63.84 qha⁻¹) in *Ber*+ greengram under 6m x 6m and lowest in *Ber*+ pearl millet under 6m x 12m spacing. Overall, system productivity in terms of *ber* equivalent yield was higher under 6m x 6m spacing than 6m x 12m. Amongst the varieties Gola registered higher yield (21.3kg/tree) and total system productivity (86.76 q ha⁻¹) irrespective of spacing and intercrops. A negative effect of *ber* on intercrops yield was seen up to two metres radial distance from the bole of trees.

Keywords: *rejuvenation, Ziziphus mauritiana, total system productivity, agrihorti systems*

PP5.4.10. From Sahara to Congo River, combining assisted natural regeneration and land tenure security to improve slash-and-burn

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Slash-and-burn agriculture (S&B) is the leading factor behind the degradation of tropical forests and represents an ecological and economic dead end. Many authors have noted that this system is very difficult to improve without the support of public policy. In dryland Africa, especially in Niger and northern Cameroon, grants funded by projects and through levies on profits from bundled cotton sales have made it possible to support the conservation of young trees on fields when fallows are cleared and during weeding. This Assisted Natural Regeneration (ANR) support policy was promoted by the state corporation responsible for the development of cotton crops and was accompanied by a delimitation and demarcation of fields. From 1990 to the present, this policy has resulted in the conservation of over one million *Faidherbia albida*, and, in so doing, the expansion and densification of agroforestry parklands.

In the equatorial wetland, of D R Congo, the experience is much more recent. Simple Management Plans of village territories were put in place since 2010 to secure rural land tenure. ANR methods have also been promoted to conserve young trees growing spontaneously in cultivated fields, after S&B, when fallows are cleared and during weeding. In areas where environment was too degraded, leguminous trees have been planted using taungya method. Trees conserved or planted improve fallow

productivity in terms of firewood and other forest products, accelerate the restoration of soil fertility and block the invasion of savanna pyrophytic vegetation, before a new 'slash-and- charcoal' cycle. Over 150 farmers have used ANR and 1700 ha of *Acacia auriculiformis* have been planted.

The use of simple techniques requiring little labour or inputs, associated with land tenure security policies, allows a gradual transition from S&B to more productive and sustainable agroforestry systems (parklands in the Sahel and improved fallow in forest areas).

Keywords: *assisted natural regeneration, improved fallow, land tenure, parklands*

PP5.4.11. Performance of high yielding provenances of bhimal (*Grewia optiva*) along with field crops in North West Himalayas

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Grewia optiva Drummond (bhimal) is one of the most important fodder trees of north western and central Himalayas up to an altitude of 1800m, grown on terrace risers with field crops. It is a medium size tree and provides nutritious leaf fodder during lean winter months when no other fodder is available. Based on a composite index of growth and productivity parameters, three most vigorous provenances of bhimal viz. I.C. Bhaintan, I.C. Chamba and I.C. Malas were identified in studies during 1995-2005 at Dehradun. The study was extended from 2006-2012 with the objectives to: (1) monitor the performance of high yielding provenances of bhimal with respect to green fodder and dry fuelwood production on farmers' fields at different locations (middle hill elevations and valley zones); and (2) monitor the productivity of various field crops in the under storey of bhimal trees at different locations. Marked differences in growth parameters in respect of mean annual increments and current annual increments were observed at valley locations (500m) and middle elevations (1300-1700 m asl). After six years of planting, average plant height at valley locations was 359.8 cm while it was 327.6 cm at middle elevations and collar diameter at middle elevations was 4.77 in comparison to 5.71 cm at valley locations. The average fresh fodder and dry fuelwood productivity was 0.189 and 0.235 Kg plant⁻¹ at middle elevations after six years while it was 0.522 and 0.407 Kg plant⁻¹ respectively at valley locations. In valley locations IC Bhaintan recorded the highest fodder yield of 0.602 Kg plant⁻¹ followed by IC Chamba at 0.503 Kg plant⁻¹. At middle elevations IC Chamba recorded the highest fodder yield at 0.222 Kg plant⁻¹ followed by IC Malas at 0.187 Kg plant⁻¹. The reduction in maize grain equivalent yield at valley locations ranged from 17.7 to 44.0% upto 4m from the tree line while this reduction was 6.2 to 27.3 in middle higher elevations after six years of planting.

Keywords: *bhimal, agroforestry, green fodder, field crops, multilocations*

PP5.4.12. Changes in soil and herbaceous plant community properties after establishment of shrubs in a hot arid region of India

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Desertification is one of the major threats to the sustainability of agriculture and economic development; and vegetation restoration is one of the most effective ways to combat desertification. *Haloxylon salicornicum* and *Calligonum polygonoides* are native shrub species in a hot region