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AGROFORESTRY RESEARCH

Using *Dalbergia sissoo* in agroforestry systems in India

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Dalbergia sissoo, locally known in India as shisham or sissoo, is a multipurpose nitrogen-fixing tree species. It is distributed throughout the sub-Himalayan tracks, from the Indus River to Assam, and in the Himalayan Valley up to around 900 to 1 500 m.

Shisham is a valuable source of timber, medicine and fodder (containing 24 percent crude protein on dry weight basis). Its wood is used for plywood manufacturing, furniture, railway sleepers and building materials. It thrives well on soils ranging from sandy loam to alluvial and in areas with rainfall ranging from 760 to 4 570 mm. In India, the tree is generally planted along roadsides, on field boundaries, in shelterbelts and on degraded lands. The species is also extensively planted in various agroforestry systems.

Boundary plantation

In central India, trees are generally planted on the farm boundaries to control the effects of the hostile agroclimatic conditions. For instance, where shisham was planted on the boundary of farmers' wheat fields, grain yields of 3.40 t/ha (average of four years) were registered. This is a relative grain yield of 98.5 percent. In four years, the overall reduction in the grain yield was negligible at only 1.5 percent. This affirms the nitrogen-fixing role of shisham in semi-arid conditions.

Shelterbelt plantation

An on-station field trial was conducted in Jhansi for two consecutive years, to ascertain the performance of rainfed food/ fodder crops, with shisham planted as a shelterbelt. The trees were eight years old and a crop rotation of sorghum (fodder)-barley (food) was selected for the trial. The trees were planted in an east-west direction, 4 m apart. The fodder crops were grown under a recommended package of practices. The crops were sown perpendicular to the tree belt (i.e. in north-south direction). The productivity of the crop was reduced significantly near the tree line, but it increased with an increasing distance from the tree line, as expected. Moisture content was high near the trees; and as the distance increased, the moisture content of the soil decreased.

Energy/block plantation

Absentee landlords commonly plant trees in close spacing for 5 to 10 years and, later on, harvest them for various purposes. Attempts were made to plant shisham in spacings of 2 m x 2 m and 2 m x 1 m under irrigated and rainfed conditions. During the first year, groundnut (under irrigated conditions) and sesame (under rainfed conditions) were sown in the interspaces, yielding 2.6 t/ha (pod) and 0.57 t/ha, respectively. But in the subsequent years, intercropping was no longer feasible.

Rehabilitation of degraded lands

Shisham has proven to be ideal for upgrading degraded lands. It has an extensive root system. Because of its suckers, the tree spreads rapidly. Because of its ability to fix atmospheric nitrogen, it is excellent in improving fertility conditions. It was reported that shisham has also been used to rehabilitate mining areas.

Planting trees in rice fields and agrisilviculture systems

Farmers have a limited choice of trees that can be planted in rice fields. Commonly, they plant mango, poplar and Singapore cotton; but shisham has been gaining popularity. *The author is the principal scientist of the Indian Grassland and Fodder Research Institute, Jhansi-Gwalior Road, Jhansi, 284 003 India.*

Agroforestry research and education in India

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Agroforestry plays an important role in India, where trees and forests are critical in ensuring sustained agricultural production, including animal husbandry and in some instances, fisheries.

The country's total land area is about 328.8 million ha, of which, forests occupy 67.7 million ha (20.5 percent). Forestry has a large and indispensable role in improving the country's present and future food security. As such, research and education in agroforestry are deemed necessary to develop, establish or sustain appropriate agroforestry systems in India.

Ancient Indians practiced agroforestry, growing *Prosopis cineraria* in the arid regions and *Acacia* species in the semi-arid regions. Similarly, for many decades now, farmers in the Central Himalayas have been cultivating *Ammomum subulatum* in combination with *Alnus nepalensis*. Various tree-crop combinations have also been cultivated in the Jhoom areas.

However, agroforestry research in India is of recent origin. In 1979, the Indian Council for Agricultural Research (ICAR) organized a national seminar on agroforestry at Imphal. The seminar constituted a task force to suggest the directions and organization for agroforestry research in India. As a result, the All-India-coordinated Research Project on Agroforestry was established. It has centers all over the country, based on the various agroclimatic zones. The National Research Centre for Agroforestry (NRCAF) was established at Jhansi in 1988.

Agroforestry research

Many of the traditional agroforestry technologies have been described, but few have been studied regarding their biophysical and socioeconomic performances. At present, substantial research resources are being allocated to determine the potential of multipurpose trees (MPTs) and agroforestry technologies in enhancing the productivity and sustainability of various farming systems.

Agroforestry research in India can be categorized as follows:

- **component research** (e.g. multipurpose tree species [MPTS] evaluation and management and nitrogen-fixing tree species); and
- **systems research** (e.g. diagnostic survey, forms of agroforestry systems and agroforestry for wasteland development/management).

Most of the agroforestry researches currently being conducted are on productivity. Not much research is being done on the sustainability and adaptability of agroforestry systems.

Agroforestry field experiments are considerably more complex than researches limited to annual crops. Thus, evaluation in agroforestry is also a complex task. Agroforestry experiments have many different objectives; thus, it is not easy to define one or even a few methods of evaluation.

Agroforestry systems

Various research institutions in India have developed agroforestry systems in different areas. The following are the most common systems, based on the nature of their components:

1. Agrisilviculture (trees + crops)
2. Boundary plantation (trees on boundary + crops)
3. Block plantation (trees + crops)
4. Energy plantation (trees + crops during initial years)
5. Alley cropping (shrubs + crops)
6. Agrihorticulture (fruit trees + crops)
7. Agrihortisilviculture (trees + fruit trees + crops)

8. Agrisilvipasture (trees + crops + pasture/animals)
9. Hortipasture (fruit trees + pasture/animals)
10. Silvipasture (trees + pasture/ animals)
11. Forage forestry (forage trees + pasture)
12. Shelterbelts (trees +/- crops)
13. Windbreaks (trees +/- crops)
14. Live fence (shrubs/under trees on boundary)
15. Homestead (multiple combinations of trees, fruit trees, etc.)
16. Entomoforestry (trees + sericulture)
17. Aquaforestry (trees + fish)

Agroforestry education

In India, there are 29 state agricultural universities, 1 central agricultural university, 4 deemed agricultural universities, and 1 horticultural university. Agroforestry, as a course, was considered with the establishment of forestry departments in different agricultural universities. The first B. Sc. Forestry program began in 1982, at the Birsa Agricultural University in Ranchi. Thirteen more agricultural universities began offering forestry courses, which included agroforestry, between 1985 and 1986. The Dr. Y.S. Parmar University of Horticulture and Forestry in Solan (HP) offers M. Sc. and Ph.D. degrees in forestry.

Moreover, some institutes also offer summer courses in agroforestry. The All-India-coordinated Research Project on Agroforestry also holds biannual workshops.

Agroforestry has indeed taken off in India, both in research and education. It is hoped that the increased offering of agroforestry courses may eventually lead to the development of agroforestry degrees and strengthened agroforestry education in the country. At the same time, agroforestry education programs may also help address the identified research gaps in agroforestry, not only focusing on its productive capabilities but also its potentials for sustainability and adaptability. *The author is the principal scientist of the Indian Grassland and Fodder Research Institute, Jhansi-Gwalior Road, Jhansi, 284 003 India.*

