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Performance of *gum* Arabic *(Acacia senegal* L.) based agroforestry models in Bundelkhand: Potential for livelihood option and increasing farmers' income

Acacia senegal (Linn) Wild a member of Mimosaceae, is a small tree of 3-6 m in height with umbrella-shaped crown. It is a typical tree of Sahel in Africa from Senegal to red sea and essentially limited to the area between 11^0 and 16^0 North, with a wide range of rainfall 100 to 800mm. It spread widely in tropical Africa from Mozambique, Zambia to Somalia, Sudan, Ethiopia, Kenya, Tanzania and Nigeria, and in South Asia in India and Pakistan. In India it is a typical tree of arid regions with a low rainfall of 100-250mm. It is drought resistant and tolerates prolonged dry period of 10-11 months, with maximum temperature reaching 50^0C with strong winds, but susceptible to frost. It occurs mostly on sand stones and skeletal soils and widely distributed as interspersed species in most of the rangelands and grasslands in arid and semi-arid regions of India.

World's 90% gum Arabic is produced from *Acacia senegal*. The quality of gum is very superior as compared to gum from any other species of *Acacia*. Nearly 90% of gum Arabic is produced by Republic of Sudan especially from (Kordafan). Production of gum Arabic is meagre in India, and contribution to the world production is negligible. The total annual output of gum Arabic is only 800 Mt compared to world production and consumption of 60,000-70,000 Mt. The domestic production is insufficient even for domestic consumption and hence, imported from Sudan and Nigeria to meet India's requirements. Gum exudes from cracks in bark of trees, mostly in the dry season. In Sudan the annual yields from young trees ranges from 188 to 2856 g (av. 0.9 kg), and from older trees, 379 to 6754 g (av. 2.0 kg). In India, however, the productivity is low varying from 175 to 550g $tree^{-1}$ $year^{-1}$. The main gum producing regions of India where natural as well as planted stands of *A. senegal* occur are in desert and arid region of Rajasthan, Gujarat, Haryana, and Punjab. The gum yield from various *Acacia* trees in their natural habitat is very poor.

In Bundelkhand, there is a good scope for extending area for large- scale plantation for production of gum Arabic. The area covered under forest, barren and uncultivable pastures, and community grazing land can be used for commercial plantation of *A. senegal.* The Bundelkhand region typically represents semi-arid climate and is prone to frequent drought. Most of the terrain is undulating with rocky and gravely surface. Cultivation of gum Arabic can provide an alternative livelihood option to the poverty stricken farming community. Assuming average yield of 250g per tree, a farmer can harvest about 25kg gum per year by planting 100 trees/ ha on field boundary or at spacing of 10 x 10 m. This would generate revenue of Rs 12500 ha^{-1} $year^{-1}$ if, gum is sold at a minimum price of Rs. 500 kg^{-1}. In addition, systematic commercial plantation of *Acacia senegal* can also provide employment to millions of people towards various planting activities and gum collection. According to an estimate of FAO, gum collection sustains about 0.3 million people and has huge potential of employment.

Integration of *Acacia senegal* in traditional grazing grounds such as *orens* and *gochars,* systematically raised silvopastoral systems and other agroforestry landuse for production of gum Arabic can be a profitable proposition. It will not only provide alternative livelihood options to local people but also increase economic viability of the land use. In consideration of wide variations in gum production in respect to sites, annual rainfall and geographical locations, it is imperative to study growth performance of *A. senegal* in different eco-regions and develop site specific models for optimizing production of gum Arabic. Research efforts are being made at Central Agroforestry Research Institute, Jhansi, a co-ordinating centres in the ICAR-network project on Natural Resin and Gums; to introduce and evaluate performance of *Acacia senegal* in agroforestry models. The main objective is to develop suitable agroforestry models based on gums and resins yielding trees for Bundelkhand region.

The study site – Jhansi is located at 24^0 11' N- 78^0 17' E with an altitude of 271 m above msl. Mean annual rainfall is 960 mm with an average of 52 rainy days per year. Mean maximum temperature ranges from 47.4^0C (June) to 23.5^0C (January) and mean minimum temperature from 27.2^0C (June) to 4.1^0C (December). The main soil types in the region are red (Alfisol) and black (Vertisol). *Acacia senegal* was planted in five agroforestry models (3 at research farm and 2 at farmer's field) in 2009. The models represent either agri-horti-silviculture or horti-silviculture system of agroforestry. In these models, *A. senegal* is planted either on boundary or as row plantation. One block plantation of *Acacia senegal* was also done at research farm. The performance of *A. senegal* has been evaluated for variation in plant height and collar diameter and exudation of gum at various sites in different models.

Plate 1. *Acacia senegal* based agroforestry models on research farm and farmer's field

Survival of *A. senegal* varied from 86 to 96% in agroforestry models established at research farm while from 54 to 78% on farmers field. Plant height, girth at breast height (gbh) and canopy of trees respectively ranged from 3.28 to 4.59m, 9.2 to 26.0cm, and 7.1 to 16.5m^2 in models raised at research farm. The respective values on farmers' field varied from 2.3 to 3.5m, 6.1 to 22.5cm and 3.4 to 6.4m^2. In general, survival and growth performance of *A. senegal* was better in agroforestry models raised at research farm than that on farmers field. Findings also revealed that *A. senegal* performed better in semi- arid region of Bundelkhand than arid region of western Rajasthan wherein after 12 years of age plants reported to attain height of about 3.0m on rocky and gravely soil. Comparatively lesser survival and growth in terms of plant height, gbh and canopy on farmers field than on research farm appears to be due to grazing hazards to saplings as *anna pratha* is practised in the region (Fig 1). In *anna pratha* the cattle are let loose, which openly graze and trembles growing saplings planted on farmers' fields. The planted seedlings require to be protected from moving cattle in beginning for 2-3 years.

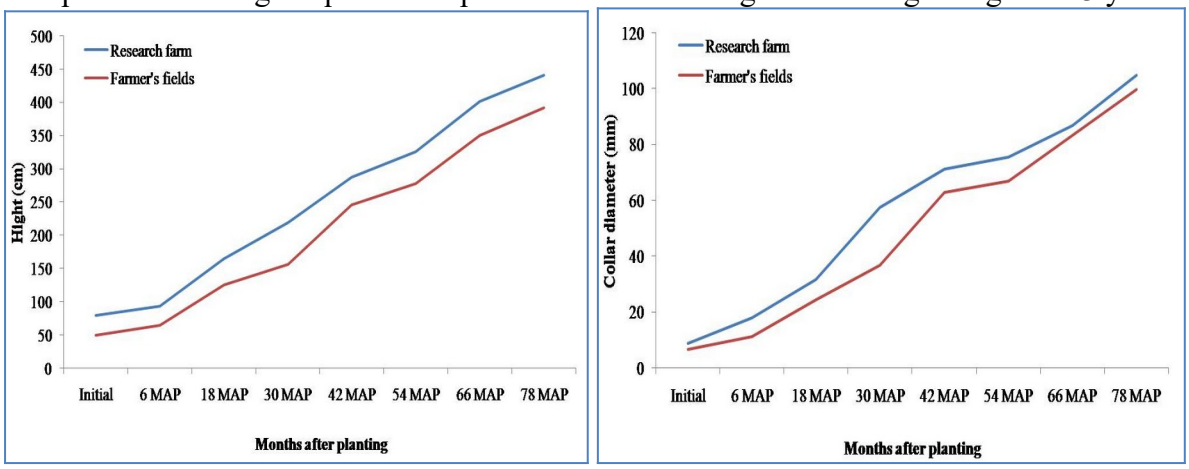

Fig 1. Comparative performance of *A. senegal* at research farm and farmer's fields

Oozing of gum has been observed in model on research farm after five years whereas it was not noticed on farmer's field. The gum yield on research farm varied from 26.1 to 134.7 g/tree with mean of 58.7 g/ tree. The number of gum tears varied from 3 to 7 per tree (Plate2).

Plate 2. Gummosis and yield of gum Arabic at research farm of ICAR-CAFRI, Jhansi

Despite constraint of *anna pratha* in Bundelkhand, the farmers of the region are getting attracted toward Gum arabic (*A. senegal*) based agroforestry models developed at CAFRI Jhansi and many farmers have planted *Acacia senegal* on their fields. The Institute is helping farmers and providing seedlings free of cost. In last five years about 8000 seedlings of gum Arabic (*A. senegal*) have been planted in parasai, chhatpur, bachouni (Jhansi in U.P.) shivrampur, dabar and garkundar (Tikamgarh in M.P) villages on farmers's field mainly as boundary plantation. The farmers preferred this species as it act as live fence besides yielding gum Arabic.

Conclusively, the results indicate that growth of *A. senegal* is very good in semi-arid region of Bundelkhand, and plantations are expected to yield good quantum of gum. This will create an opportunity for farmers to earn extra income for their family.

Acknowledgement

The authors are thankful to the farmers of different villages for extending cooperation and adopting gum yielding tree plantations on their fields. The financial help extended by Indian Council of Agricultural Research, New Delhi in the form of ICAR-Network Project on HPVA of NRG is thankfully acknowledged.

Rajendra Prasad, Ramesh Singh, A. K. Handa, B. Alam, R. K. Tewari, O.P. Chaturvedi, Ashok Shukla, Prashant Singh, V. D. Tripathi and A. K. Singh

ICAR-Central Agroforestry Research Institute, Jhansi- 284 003 (U.P.)

Visits Sh. Swatantra Dev Singh

Hon'ble Swatantra Dev Singh, Minister of State with Independent Charge for Transport & Protocol and Minister of State for Power in the Government of Uttar Pradesh visited the Institute on 25 September, 2017.

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ICAR- ICRAF Work Plan Meeting

An exposure visit and a meeting were held for Formulation/development and implementation of “National Agroforestry Policy” for Nepal during 11th -12th August, 2017. In this meeting Senior officials from different Ministries, Government of Nepal, officials from ICRAF and ICAR- CAFRI participated. This interaction meeting was conducted by ISAF, ICAR- CAFRI and ICRAF (New Delhi Centre) under ICAR- ICRAF Work plan.

Swachh Bharat Abhiyan

Various awareness programmes about cleanliness were conducted during 17th September to 1st October, 2017.

Cleanliness drive programmes were organized in the Institute campus as well as in the villages. Farmers were motivated for tree plantation, organic farming and cleanliness.

Human Resource Development

Dr. Dhiraj Kumar, Scientist (Soil Science) participated in the Training programme on "Advanced Remote Sensing and GIS Applications in Integrated Land Resource Management" from July 17-29, 2017 at ICAR-NBSS & LUP, Nagpur.

Dr. A K Handa, Pr. Scientist participated in the Standard Development Group meeting of Trees Outside Forest on 5th August, 2017 in New Delhi organized by Network for Certification and Conservation of Forests.

Dr. A K Handa participated in Regional Workshop on Development of SAARC Regional Project on Community based Non Wood Forest Product Enterprise: A sustainable business model during 24th -26th August, 2017 at Thimpu, Bhutan.

Dr. Sudhir Kumar and Sh. Lal Chand participated in the International Conference on "Horticulture: Priories & Emerging Trends" during 5th -8th September, 2017 held at IIHR, Bengaluru.

Dr. R. H. Rizvi participated in the National Symposium on "Application of Remote Sensing & GIS in Indian Scenario with Special Reference to Agriculture & Forestry" during 15th-16th September, 2017 at UAS, Dharwad held at College of Forestry, Sirsi.

Dr. Inder Dev and Dr. Naresh Kumar participated in the National Conference on "Alternate Farming Systems to Enhance Farmers' Income" during 19th -21st September, 2017 held at Y.S. Parmar, UHF, Nauni, Solan (H.P.).
Dr. Naresh Kumar participated and delivered a lecture on the topic "Effect of growing media and arbuscular mycorrhizal fungi on seedling growth of *Leucaena leucocephala* (Lam.) de Wit" in National Conference on Alternate Farming Systems to Enhance Farmers' Income during 19th -21st September 2017 organized by Indian Ecological Society- Himachal Chapter, Directorate of Research, YSP University of Horticulture and Forestry Nauni, Solan (HP) at Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan 173230, H.P.

Awards

1. Dr. Naresh Kumar Got the 3rd **Best paper presentation award** in National Conference on "Alternate Farming Systems to Enhance Farmers' Income" during 19th-21st September 2017 organized by Indian Ecological Society- Himachal Chapter,

Directorate of Research, YSP University of Horticulture and Forestry Nauni, Solan (HP) at Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, H.P.

2. Dr. Naresh Kumar Got the **"Distinguished Service Award – 2017"** from Society of Biological Sciences & Rural Development, Allahabad – 211019, U.P.

Exhibition

Institute participated in three days Antyodaya Mela/exhibition during 18th -20th September, 2017 at Jhansi, U.P. In the exhibition, agroforestry technologies, biodiesels and watershed management technologies exhibited to the farmers, students and other stakeholders. Sh. Ravi Sharma, MLA (Sadar), Sh. A. Dinesh Kumar (IAS and CDO, Jhansi) and Sh. Karn Singh Chauhan (District collector, Jhansi) visited the CAFRI stall and appreciated CAFRI efforts. The exhibition was very successful and increased awareness about benefits of agroforestry in the era of climate change. Dr. Asha Ram, Dr. Dhiraj Kumar and Sh. Lal Chand, ICAR-CAFRI participated in the exhibition.

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