Annals of Arid Zone 52(1): 39-44, 2013

CAZRI Gum Inducer for Gum Production from *Acacia senegal*: Potential and SWOT Analysis

P. Ratha Krishnan, J.C. Tewari and T.K. Bhati

Central Arid Zone Research Institute, Jodhpur 342 003, India

Received: December 2012

Abstract: The technique of increased gum Arabic production from *Acacia senegal* using CAZRI gum inducer is a popular and well accepted strategy among the rural folk of Indian arid zone. It was evident the increased demand for the CAZRI gum inducer (ethephon) over years for the gum Arabic production in arid Rajasthan. Central Arid Zone Research Institute, Jodhpur, is the sole supplier of CAZRI gum inducer, therefore the increased sale trends revealed its acceptance and wide adaptability. It was also reflected by the increased sale of *A. senegal* seedlings from CAZRI for field planting. This paper summarizes the efforts to develop participatory mode of increased gum production and its SWOT (Strength, Weakness, Opportunity and Threats) analysis in the villages, where this technology was not known to the farmers. The analysis revealed the success of participatory gum production technology by win-win situation to all its stakeholders. The success of gum exudation depends on proper utilization of this technique. Hence, decentralized availability of gum inducer through any authorized distribution system is desirable to ensure the lateral spread of CAZRI's proven technology, which also assures the distribution of quality gum Arabic inducer at a low price.

Key words: *Acacia senegal*, gum inducer, participatory, SWOT analysis, technology.

The Indian hot arid region spreading over an area of about 0.32 million km^2 forms a continuous stretch covering the states of Rajasthan, Gujarat, Punjab, Haryana and parts of Maharashtra, Karnataka and Andhra Pradesh. Low and erratic rainfall, extreme temperatures, high wind velocity and high evapo-transpiration are characteristic features of this region. The climate and edaphic features of arid regions are very inhospitable; hence the natural vegetation of this region is sparse and mainly consists of pasture lands. In such circumstances, perennial-based farming system has the potential to be practiced due to the ability of perennials to withstand adverse climatic conditions. Among them *Acacia* and *Prosopis* based agrisilviculture systems are time tested traditional farming practices of this region. *Acacia* based agroforestry system gives higher returns compared to sole cultivation of pearl millet or trees. *Acacia senegal* provides seeds that can be used as vegetable and the gum extraction from the tree increases returns from this system (Harsh *et al.,* 2000). Indian arid zone is the most populated arid zone of the world with an average population of 127 persons km^{-2} (as per 2011 census), against 6-8 persons km^{-2} in other arid zones of the world. Thus human factor also contributes to acute biotic stress on these sparse natural resources. Decline in common property resources is a result of multiple biotic and abiotic factors, which is often not easy to measure, especially in present scenario of climate change. Considering the above facts, restoration/rehabilitation of the marginal rangelands in participatory mode is the possible alternate to protect the available resources while ensuring the improvement of quality of life (Jodha, 1985).

In arid north-western parts of India, *Prosopis cineraria* and *Acacia senegal* are prominent tree species which satisfy the food, fodder and fuel wood requirements of rural folk. Among them, the market and medicinal value of gum Arabic and seeds as vegetable make *A. senegal* a commercial tree of the region. However, the natural gum production from *A. senegal* is meager despite the occurrence of extensive stands of the species in the drier parts of Rajasthan, Gujarat, Madhya Pradesh and Haryana. Consequently, the country imports 5,000 tones of the gum Arabic annually, especially from Sudan, costing Rs 7.3 million. The average international price of the Sudanese gum Arabic is ~US $ 1,500 t^{-1} (Anon, 2009). On

*E-mail: ratha_forestry@yahoo.co.in

the other hand, the pioneer study conducted at CAZRI, Jodhpur, with repeated trials and experimentation for enhanced induction of gum Arabic revealed that 0.8 to 0.9 kg of good quality gum can be obtained per tree by using CAZRI gum inducer @ 4 ml (Ethephon solution with active ingredient of 195 mg ml^{-1} of solution) through a hole in the sapwood in April/May. This well proven gum Arabic exudation technology of CAZRI has been attempted in participatory mode at villages Bujawar and Rohilakalan of Jodhpur district, to improve the livelihood of rural folk.

Materials and Methods

The sale analysis of *Acacia senegal* seedlings and CAZRI gum inducer from CAZRI for the past four years was carried out after compilation, enumeration and study of sales records. For SWOT and participatory analysis of gum Arabic production, field surveys were conducted at the villages Bujawar and Rohilakalan located in Luni Block, Doli Gram Panchayat of Jodhpur district, Rajasthan (72°50′ to 72°54′E longitudes and 26°10′ to 26°16′N latitudes) having an area of 1,508 ha with total annual rainfall ranging from 250 to 400 mm. Soils of the villages are coarse loamy, with low organic matter (0.06-0.13%), low to medium available phosphorus (8.01 kg ha^{-1}) and medium to high available potassium (101-349 kg ha^{-1}) with varying degrees of wind and water erosion hazards. The soils can be put into the land capability classes IIc, III cew, III csa, IV caew and VIII r. The land use statistics of the villages revealed 32% area as hilly and rocky, 6% permanent pastures and sandy wasteland, 33% arable land, and 30% as fallow (Anonymous, 2011). These villages had seven main streams originating from rocky terrain areas and passing through several farmlands.

Before these interventions, the villagers were not concerned about the perennials because their main livelihood option was stone quarrying. They consider *A. senegal* trees as a source of fuel wood, while only few farmers seldom collected its naturally exuding gum from the wild population for their household consumption. Since more trees were available in the sites near nalas (water channels), the randomly selected farmers who had gum Arabic trees on their fields were provided girmet (a hand driven drilling tool) and CAZRI gum inducer during the month of April, 2012. Within a month about 500 trees were treated by 25 respondents under marginal farmer category. The farmers were interviewed during May-June, 2012 for the assessment of gum production, SWOT analysis and to know the impact of this participatory gum production technology for employment and income generation. It has been established that gum Arabic inducing technology developed at CAZRI (Khan and Harsh, 1994) has the potential to double the income by production of more gum in comparison to traditional systems of gum exudation (Harsh *et al.,* 2000).

Following are the steps of standardized CAZRI gum inducing technology:

- Healthy *A. senegal* trees of more than 8 years of age, which have attained more than 6″ diameter at breast height are suitable for gum exudation.
- Generally, trees growing on sandy dunes, plains and water courses are more suitable, while the trees available in rocky terrain must be avoided for gum exudation.
- A downward slanting 1.0 to 1.5″ deep hole of about 1.5 to 2 cm diameter is drilled 1′ above the collar of the tree with the help of hand driven girmet or battery operated drilling machine.
- CAZRI gum inducer (3.5 to 4.0 ml) is filled into the hole and the hole is patched up with wet clay/pond silt.
- Yearly treatment of same tree should be avoided while alternate year of treatment without affecting the tree survival and vigor may safely be attempted.
- The tree starts exuding gum tears after 5-10 days of treatment. Best period of treatment is February to May (preferably when the ambient temperature is >35°C and no rains are there).
- Four times gum picking is possible with 400-500 g gum per tree in a season.

Planting of *A. senegal* trees on farm boundaries is a recognized practice in arid Rajasthan due to the protective role of its thorns and adaptability to harsh climate. Even then its preference for planting was very less. Farmer's perception analysis was also carried out in the study area to evaluate the views of rural folk on gum

Arabic trees before and after the intervention of CAZRI gum exudation technique.

Results and Discussion

Sale of gum yielding tree seedlings and CAZRI gum inducer

Table 1 clearly indicates the annual increase in sale of *A. senegal* seedlings over the years (from 1019 during 2008-09 to 4309 during 2011-12). This may perhaps be due to the increased awareness of the arid zone rural folk about exploiting *A. senegal* trees for gum Arabic exudation, which is used in many products of human consumption.

Table 1. Gum yielding tree seedlings sold from CAZRI, Jodhpur during April 2008 to March 2012

Species	2008-09	2009-10	2010-11	2011-12
Acacia nilotica	194	240	4750	1460
Acacia senegal	1019	13386	2172	4309
Acacia tortilis	517	2301	70	540
Anogeissus spp.	-	-	-	50
Azadirachta indica	1639	2117	6587	7076
Commiphora wightii	-	18	286	100
Moringa spp.	123	107	88	22
Prosopis cineraria	862	2393	1688	2697
P. juliflora	1665	55	1090	128
Total	6019	20617	16731	16382

Table 2 indicates the increase in sale of CAZRI gum inducer (from 12,100 doses in 2008-09 to 27,500 doses in 2011-12) and its subsequent impact on total gum Arabic production (5.45 t in 2008-09 to 11.0 t in 2011-12). Hence from 2008-09 to 2011-12, farmers in 45 target villages of arid western Rajasthan earned revenue to the tune of Rs. 19.49 million by the sale of gum Arabic (Anonymous, 2012).

Participatory gum inducing technology: A case study-cum-success story

The field survey revealed that the population of *A. senegal* is more (20 to 75 trees per running km) on the sites near/border of nalas (water channels), while farmers rarely maintain *A. senegal* trees on their fields (0 to 21 trees ha^{-1}). It may be perhaps due to its adverse effects on understory crops. Wild population was also noticed in the hillocks (Anonymous, 2011). The technology of increased gum production from *A. senegal* trees is well adopted in arid Rajasthan, surprisingly villagers in the study area were not aware about the technology. Hence, an intervention of using CAZRI gum inducer to increase gum Arabic production from *A. senegal* trees was initiated in participatory mode. After repeated awareness campaigns, a field training on "Increased gum Arabic production from *A. senegal* trees" was given to the villagers under the SUMAMAD project. Subsequently the girmet and CAZRI gum inducer were distributed to 25 farmers. Within a fortnight about 500 trees were treated by the farmers during April / May and the gum was harvested and used for their consumption. Gum yield varied from approximately 100 g $tree^{-1}$ in irrigated area to 320 g $tree^{-1}$ in rainfed area. Similarly trees growing on boundaries of water channels yielded more gum compared to those growing inside the fields. These results indicated that the water availability has some influence on gum yield of *A. senegal*. An additional income of approximately Rs. 1,00,000 was earned by farmers due to this activity (assuming an average gum yield of 200 g $tree^{-1}$ for 500 trees with the market price of gum being Rs. 1000 kg^{-1}). It was calculated that, this activity generated about 20 man days of work for drilling holes and applying gum inducer and 32 man days for gum collection activity within a period of 75 days (mid-April to June). By investing Rs. 10 per tree for the cost of CAZRI gum inducer dose, and spare time for drilling, treatment and gum collection the farmer can earn approximately Rs. 200 per tree by way of market value of gum. Hence, this activity offer the benefit cost ratio of about 20:1. This income

Table 2. Gum Arabic production and economic returns in 45 target villages of Barmer, Jodhpur and Nagaur districts of arid western Rajasthan

Particulars	Years				Total
	2008-09	2009-10	2010-11	2011-12	
Number of *A. senegal* trees treated (in '000s)	12.10	20.95	22.61	27.50	83.16
Production of gum Arabic by farmers (tons)	5.45	10.48	7.67	11.00	34.60
Total income earned by farmers (million Rs.)	2.72	5.24	3.83	7.70	19.49
Revenue generated by CAZRI (million Rs.)	0.12	0.21	0.23	0.28	0.83

Source: Anonymous, 2012.

generation activity was well recognized by the farmers and resulted in tremendous increase in demand for gum Arabic seedlings for planting on field boundaries, which was also reflected in the sales trend of *A. senegal* seedlings from CAZRI (Table 1). The overwhelming response of farmers towards gum exudation activity during April to June is also due to the fact that the rabi crop is harvested by this time and the farmers have ample spare time for this activity and perennials planting just before rains. It also changed the perception of farmers about *A. senegal* trees from being less worthy to valuable (Fig. 1).

To cater the seedling requirement of villages, two field nurseries were established during 2011-12 under the SUMAMAD project by Sh. Bhopal Singh S/o Sh. Malm Singh and Sh. Chater Singh S/o Sh. Kishore Singh from village Bujawar in participatory mode under our technical guidance. Besides raising the seedlings of *A. senegal*, they were also encouraged to raise seedlings of several other multipurpose trees and vegetables as per the demand of the villagers and nearby farmers. From June to September, they had raised about 5000 quality saplings of MPTs including *A. senegal* and vegetables, which were sold by the end of September. This on-site availability of vegetable seedlings attracted even the farm laborers to plant seedlings in their backyards to meet their daily vegetable needs, which indirectly offers scope for nutritional security in those villages. This activity besides fulfilling the demand of seedlings also helped in employment generation (approximately 100 man days) and generation of an additional income of Rs. 25,000 by sale of seedlings. Impressed by the success of this activity, two more farmers (Sh. Guman Singh S/o Pep Singh and Sh. Guman Singh S/o Ugam Singh) from village Bujawar came forward and initiated the nursery activity under our guidance. They also produced about 2500 tree seedlings successfully by the end of November. This kind of perennial system of management proved a win-win situation for the technology providers as well as the practitioners in participatory mode of implementation.

The emphasis on this kind of participatory approach arose from the wisdom and realization of the role of local communities due to their deep understanding of their problems and also best possible solutions. This made them to participate as beneficiaries and also as providers (Kalibo and Medley, 2007). Within the natural resource sector, the participatory approach argument became a focal point and attracted a great deal of attention, following the Rio Earth Summit, where it was accepted as an integral part of the sustainable development process (Kelly, 2001). Participatory mode of approach by involving all key stakeholders in the process of resource management, understanding their needs and situations may improve the livelihood of farmers. Meanwhile, participatory research will go a long way to secure and promote local sustainable resource management (Johnson *et al.,* 2004).

SWOT analysis of CAZRI gum inducing technology from Acacia senegal

Strength

- CAZRI, Jodhpur, is well connected to the public due to its close proximity and

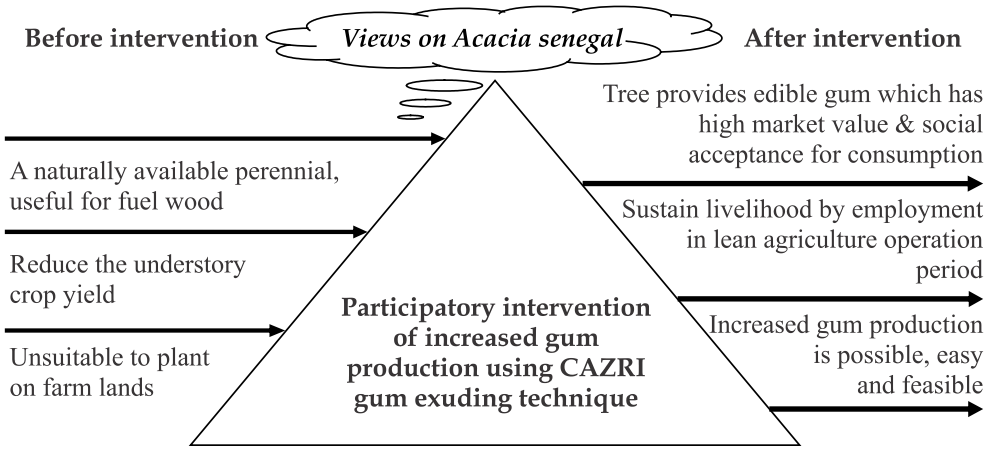

Fig. 1. Farmer's perception on A. senegal - before and after the intervention of CAZRI gum exudation technique.

availability of gum inducer (till date CAZRI is the sole supplier of the gum inducer).

- On site hands-on training and dissemination of technical know how about the increased gum production using CAZRI gum inducer technique to the stakeholders.
- Sufficient availability of man power to execute the activity. Simple mode of execution process made it effectively practiced by women, youths and age old too.
- Long shelf-life of the produce (gum) and its eco-friendly way of collection and processing.
- Assured market value for the gum Arabic and its traditional/local consumption.
- Execution of the process in a time frame when agricultural operations are in lean phase.

Weakness

- Least concern to agricultural activity due to the priority of stone quarrying.
- Marginal and small farm land holdings of farmers.
- Availability of dense stands of *A. senegal* trees near/border of nalas which is a common property resource having possibility to create ownership issues between the stakeholders.
- Inclination of farmers/stakeholders to get free supply of CAZRI gum inducer and other agricultural inputs from government agencies, instead of investing their own resources.

Opportunity

- Availability of large number of *A. senegal* trees in and around the villages and the ever increasing demand of gum Arabic.
- Tapping of economic benefits from the naturally available tree resources in the arid zone.
- Employment generation during the lean agricultural period (during hot summer months i.e., April to June) when the fields are barren.
- Network of CAZRI gum inducer sale, production of gum, it's value addition and marketing of produce.
- Value chain on gum Arabic and seeds due to their wide spread use as an ingredient in local/traditional dishes, international market and adulteration in gum Arabic.
- Decentralization of gum inducer sale through market, KVK or other distribution systems to ensure its proper usage and avoid black marketing.

Threats

- Field data collection: Conscious reply on actual yield data conveyed to the data collecting staff involved in the activity.
- Improper application: Threat of mortality of trees, lesser gum production and the expected, mixing of dust and other plant parts in exuded gum, etc.

Conclusions

The technique of increased gum production from *A. senegal* by using CAZRI gum inducer has been well accepted by the primary stakeholders in arid western Rajasthan, as witnessed by the increased demand for CAZRI gum inducer over years as well as by gum Arabic production in this tract. Implementation of the proven technologies like the gum exudation from *A. senegal* in participatory mode assures the win-win situation to the technology provider as well as the technology practitioner. The decentralized availability of CAZRI gum inducer through any authorized distribution system can ensure the lateral spread of CAZRI's proven technology to even the remote pockets of arid region. It will ensure an easy distribution of quality gum inducer which in turn will increase the quantity, quality of exuded gum and will also ensure the generation of economic benefits to the farmers.

Acknowledgments

This work was supported by the UNESCO funded SUMAMAD, Phase-II project. The authors acknowledge the network project on natural resins and gums from where the secondary data were collated. The authors are also thankful to the Director, CAZRI, for encouragement and support throughout the course of study.

References

Anonymous 2009. *Post-harvest Management and Value Addition,* DARE/ICAR, Annual Report 2008 - 2009, pp. 72-80.

Anonymous 2011. *Progress Report of SUMAMAD Activities on Rehabilitation of Degraded Rangelands and Stabilization of Production in Arable Arid Land of Thar Desert of India*, CAZRI, Jodhpur, UNESCO, Paris, 29 p.

Anonymous 2012. *Proceeding of the 4th Coordination Committee Meeting of Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums*, IINRG, Ranchi, 14-15 September, 2012, 7 p.

Harsh, L.N., Tewari, J.C. and Bohra, M.D. 2000. Traditional and improved agroforestry systems for sustainable agriculture in the arid region of India. In *Proceedings of International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century*. Vol. 3, pp. 1035-1037. WTC, IARI, New Delhi.

Jodha, N.S. 1985. Population growth and the decline of common property resources in Rajasthan, India. *Population and Development Review* 11(2): 247-264.

Johnson, N.L., Lilja, N., Ashby, J.A. and Garcia, J.A. 2004. The practice of participatory research and gender analysis in natural resource management. *Natural Resources Forum* 28(3): 189-200.

Kalibo, H.K. and Medley, K.E. 2007. Participatory resource mapping for adaptive collaborative management at Mt. Kasigau, Kenya. *Landscape and Urban Planning* 82(3): 145-158.

Kelly, D. 2001. *Community Participation in Rangeland Management*, A Report for the Rural Industries Research and Development Corporation (RIRDC), RIRDC Publication No. 01/118; RIRDC, Project No. QDL-2A, RIRDC, Australia.

Khan, H.A. and Harsh, L.N. 1994. Quality of ethephon induced gum from *Acacia senegal*. *Annals of Arid Zone* 33(1): 85.

Printed in March 2014