



**Indian Council of Agricultural Research**  
(कृषि अभियांत्रिकी प्रभाग / **Agricultural Engineering Division**)  
(कृषि अभियांत्रिकी अनुभाग / **Agricultural Engineering Section**)  
कृषि अनुसन्धान भवन-II, पूसा, नई दिल्ली  
**Krishi Anusandhan Bhavan - II, Pusa, New Delhi**

F.No. A.Engg.12/1/2022-AE, C.No. 175129

Dated: 19.01.2022

To

**Dr. K.K. Sharma,**  
Director,  
ICAR-IINRG,  
Namkum, Ranchi-834010, Jharkhand  
E-mail [niranjan\\_ilri\\_1999@yahoo.com](mailto:niranjan_ilri_1999@yahoo.com)

**Subject: - Approval for Proceeding of 13<sup>th</sup> Annual Workshop of Network Project on "harvesting Processing and Value Addition of Natural Resins and Gums" held during 09-10 November, 2021 via Online Virtual Platform.**

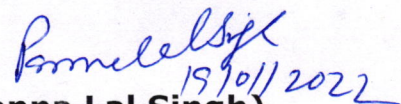
**Sir,**

This is in reference to your email dated 13/01/2022 vide letter No. NP-NRG/(cc)/2021 on the subject mentioned above. The approval of the competent authority is hereby conveyed for Proceeding of 13<sup>th</sup> Annual Workshop of Network Project on "Harvesting, Processing and Value Addition of Natural Resins and Gums" during 09-10, November, 2021 through On-line Virtual Platform. However, DDG (Engg.) has suggested to mention the following on each ongoing and completed project in the proceeding before circulation.

1. No of research paper published with NAAS rating
2. No of research paper presented
3. No of technologies developed
4. No of technologies licensed

This issues with the approval of DDG (Engg.)

Yours faithfully,

  
**(Panna Lal Singh)**  
Principal Scientist (FE)



प्राकृतिक राल एवं गोंद के संग्रहण, प्रसंस्करण एवं  
मूल्य संबर्धन पर नेटवर्क परियोजना

Network Project on Harvesting, Processing and Value Addition of  
Natural Resins and Gums

भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान, नामकुम, रॉंची-834010

**ICAR- Indian Institute of Natural Resins and Gums**

Namkum, Ranchi- 834010, Jharkhand

No. /संख्या: NP- NRG/6 (cc)/2021/

Date/ दिनांक:

To

**Dr. K. K. Singh**  
**Assistant Director General (Farm Engineering)**  
**Indian Council of Agricultural Research**  
**KAB-II, Pusa, New Delhi- 110012**

**Sub: Proceedings of 13<sup>th</sup> Annual Workshop of Network Project on “Harvesting, Processing and Value Addition of Natural Resins and Gums” for approval.**

Sir,

In the above reference, please find for approval, the Proceedings of the 13<sup>th</sup> Annual Workshop of Network Project on “Harvesting, Processing and Value Addition of Natural Resins and Gums”, which was organized during November 09-10, 2021 via Online Virtual Platform.

The approval of the same may please be conveyed.

Thanking you,

Yours sincerely

(K. K. Sharma)

Director

**Encl.: Proceedings of the 13<sup>th</sup> Annual Workshop of Network Project on “Harvesting, Processing and Value Addition of Natural Resins and Gums”**

## Main Proceedings

### ICAR-CAZRI, Jodhpur

1.	Centre Name	ICAR-CAZRI, Jodhpur
2.	PI Name	Dr. Archana Verma
	Co-PI Names	Mr. Shiran K, Scientist (Agro forestry) Dr. (Mrs.) Pratibha Tewari, PS Dr. M.B. Noor Mohamed Ms. Subbulakshmi V. Dr. Saurabh Swami,
3.	Names of Other Technical and Non-Technical Staff Working	Dr. Kamlesh Pareek, RA
4.	Budget Provision for the Current Year	₹14.5 Lakh
5.	Money Spent in the Current Year	₹12.35Lakh

#### 6. On-going Sub-Projects:

Sl. No.	Projects	Start Date	Date of Completion
1	To study gum production potential of various tree species in the arid region	2016	2023
2	Extension of gum inducing technique in arid regions of Rajasthan.	2015	2023
3	Plantation establishment, maintenance and evaluation of high gum yielding plant type of <i>Acacia senegal</i> and <i>Butea monosperma</i>	2017	2023
4	Evaluation of <i>Acacia senegal</i> and <i>Acacia tortilis</i> gums as wall materials for encapsulation of Phytochemicals.	2018	2025
5	Value addition of gum Arabic through convenient technology.	2018	2025

#### 7. Approved New Sub-Project:

S. No.	Sub-Projects	Start Date	Completion Date
1.	Evaluating commercial potential of lesser-known gum of arid region	2021	2025

#### **Recommendations:**

- ATR on recommendations of the 12<sup>th</sup> Annual Workshop needs to be revised.
- Centre should discontinue very long projects.
- New project need to be oriented to address the complete value chain of the commercially important major/minor gums of arid region.
- Centre should develop method/technique for identification of gums of arid region to check adulteration.

## IGKV, Raipur

1.	Centre Name	IGKV, Raipur
2.	PI Name	Dr. S Patel
	Co-PI Names	Dr. (Smt.) Pratibha Katiyar Er. Prashant Pisalkar
3.	Names of Other Technical and Non-Technical Staff Working	Er. Pooja Sahu, SRF
4.	Budget Provision for the Current Year	₹ 14.5 Lakh
5.	Money Spent in the Current Year	₹ 9.55 Lakh

### 6. On-going Sub-Projects:

Sl. No	Projects	Start Date	Date of Completion
1.	Sustainable utilization of gum and resin by establishing improved tapping technique in Dhawara/Ghatti ( <i>Anogeissus latifolia</i> )	April 2015	Long term
2.	Sustainable utilization of gum and resin by establishing improved tapping technique in Sal ( <i>Shorea robusta</i> ) and Salai ( <i>Boswellia serrata</i> )	Nov. 2016	Long term
3.	Development of tapping techniques for sustainable extraction of biopolymer in Rohini ( <i>Soymida febrifuing</i> Roxb), Chironji ( <i>Buchanania lanzan Spreng</i> ) and Saja ( <i>Terminalia tomentosa</i> Roxb.)	Nov. 2017	Long term
4.	Development of scientific harvesting and collection of Palash ( <i>Butea monosperm</i> ) gum, Kamarkas.	April 2019	Dec. 2022
5.	Studies on fortification of Babool gum ( <i>Acacia nilotica</i> ) in the preparation of extruded product	July 2021	Dec. 2023

### 7. Approved New Sub-Project: Nil

### Recommendations:

- Centre should reconfirm presence of heavy metals in tapped gums before reporting.
- Final recommendations of gum tapping methods for *karaya*, *ghatti*, *saja* and *chiraunji* need to be prepared and published for adoption.
- New project need to be oriented to address the complete value chain of the commercially important assigned to the centre.
- Effort should be made to commercialize the gum based extruded products developed by the centre.



## JNKVV, Jabalpur

1.	Centre Name	JNKVV, Jabalpur
2.	PI Name	Dr. Moni Thomas
	Co-PI Names	-
3.	Names of Other Technical and Non-Technical Staff Working	Dr. NirajTripathi, RA
4.	Budget Provision for the Current Year	₹ 14.5 Lakh
5.	Money Spent in the Current Year	₹ 9.25 Lakh

### 6. On-going Sub-Projects

Sl. No	Projects	Start Date	Date of Completion
1.	Qualitative analysis of guggul gum stored in moist earthen pots.	2019	2022
2.	Plantation drive through public participation	2019	2022
3.	Skilled field training on sustainable harvesting of guggul with JawaharGuggul Blazer	2019	2022

### 7. Approved New Sub-Project:

Sl. No	Projects	Start Date	Date of Completion
1	Large scale production of Jawahar Guggul Laddu	2021	2022
2	Study on shelf life of Jawahar Guggul Laddu	2021	2023
3	Qualitative analysis of freshly harvested guggul from different states	2021	2023
4	Evaluation of performance of Jawahar drupe collector	2021	2023

### Recommendations:

- New project need to be focused to address the complete value chain of the guggul.
- New project proposal should be submitted in RPP-I format.
- Reanalyze the experimental data related to change in *guggul* essential oil content during storage.

### VNMKV, Parbhani

1.	Centre Name	VNMKV, Parbhani
2.	PI Name	Dr. R.B. Kshirsagar
	Co-PI Names	-
3.	Names of Other Technical and Non-Technical Staff Working	Dr. BA Jadhav, RA
4.	Budget Provision for the Current Year	₹ 14.5 Lakh
5.	Money Spent in the Current Year	₹ 10.25 Lakh

#### 6. On-going Sub-Projects:

Sl. No	Projects	Start Date	Date of Completion
1.	Effect of feeding different of guar korma meal on growth performance on Kaveri chicken	2020	Sept 2021

#### 7. Approved New Sub-Projects:

Sl. No	Projects	Start Date	Date of Completion
1.	Development of Pet food with incorporation of guar meal protein isolate	2021	2022
2.	Development of pasta by incorporation of Guar Meal Protein Isolate	2021	2022
3.	Utilization of PHGG in tomato soup mixes	2021	2022

#### **Recommendations:**

- Centre should compare the products developed with commercially available products w.r.t. quality, shelf life, cost etc. before commercialization.
- Before taking new project, previous work carried out need to be thoroughly reviewed and published in form of review / status paper.
- Centre should focus on taking new project targeting to enhance the value of guar gum/ by products of guar gum industries.
- Work related cultivation of guar is not covered under the objective of the Network Project. Accordingly, centre need not to propose guar cultivation related project under this Network Project.

## TNAU, Coimbatore

1.	Centre Name	TNAU, Coimbatore
2.	PI Name	Dr. A Balasubramanian
	Co-PI Names	Dr. S Radhakrishnan Dr.P.Vennila Dr.M.Sivaprakash Dr.M.Suganthi
3.	Names of Other Technical and Non-Technical Staff Working	Dr. C.N. Hari Prasath, SRF Mr. ThiruMoorthy, SRF
4.	Budget Provision for the Current Year	₹ 14.5 Lakh
5.	Money Spent in the Current Year	₹ 11.95 Lakh

### 6. On-going Sub-Projects

Sl. No	Projects	Start Date	Date of Completion
1	To study production, processing, marketing and utilization of Tamarind seed gum	2014	2022
2	To develop and standardize protocols for harvesting and processing of tamarind fruits and seeds	2014	2022
3	To improve/refine the primary processing techniques for enhanced recovery and quality of Tamarind seed gum	2014	2022
4	To improve the process and machinery for making value added products with IINRG, Ranchi and other institutes	2014	2022
5	To transfer the tamarind seed gum technologies in the region	2014	2022

### 7. Approved New Sub-Projects:

Sl. No	Projects	Start Date	Date of Completion
1	Standardization of gum extraction technique for Moringa ( <i>Moringa oleifera</i> )	April, 2020	March, 2023

### **Recommendations:**

- The experiment of gum tapping from moringa (*Moringa oleifera*) should be continued for the next 2 – 3 years to know the effect of gum inducer (ethephon)
- Centre should focus on taking new project targeting to enhance the value of TKP by products of TKP industries.

### Dr. YSPUHF, Nauni, Solan

1.	Centre Name	Dr. YSPUH & F, Solan
2.	PI Name	Dr. Bhupender Dutt
	Co-PI Names	Dr. Rajneesh Kumar Dr. Meenu Sood Dr. Yash Pal Sharma
3.	Names of Other Technical and Non-Technical Staff Working	Dr.Heena, RA
4.	Budget Provision for the Current Year	₹ 14.5 Lakh
5.	Money Spent in the Current Year	₹ 10.1 Lakh

#### 6. On-going Sub-Projects:

Sl. No	Projects	Date of start	Date of completion
1	Effect of oleoresin storage on turpentine content in <i>Pinus roxburghii</i> Sargent	April,2020	March, 2023
2	Effect of anatomical characteristics on oleoresin yield	April,2017	March, 2020
3	To study the physico-chemical characteristics of wood of <i>Pinus roxburghii</i> from different progenies	April,2020	March, 2021
4	Demonstration of Borehole Technology of Oleoresin Tapping	April,2016	Long Term

#### 7. Approved New Sub-Projects: NIL

#### Recommendations:

- Centre should find out the reason for maximum resin production with 40° angled boreholes as reported.
- Diameter classes of the trees selected for resin tapping experiments with borehole and rill method should be the same for comparison.
- A standardized protocol for resin tapping should published in form of bulletin, booklet, paper, etc.
- Subprojects should be formulated for the next five years considering the objective and mandate of the Network Project and project related to application development and value addition of rosin need to be taken.



## KAU, Thrissur

1.	Centre Name	KAU, Thrissur
2.	PI Name	Dr. S Gopakumar
	Co-PI Names	-
3.	Names of Other Technical and Non-Technical Staff Working	Mr. Sajith M S, SRF
4.	Budget Provision for the Current Year	₹ 14.5 Lakh
5.	Money Spent in the Current Year	₹ 8.5 Lakh

### 6. On-going Sub-Projects:

Sl. No	Projects	Start Date	Date of Completion
1.	To document the phenological events of the gum and resin yielding trees of Western Ghats	Jan. 2021	Dec. 2022
2.	To develop a germplasm of gum and resin yielding trees of Western Ghats	Jan. 2021	Dec. 2022
3.	Standardization of nursery techniques of <i>Canarium strictum</i> (Black dammar) and <i>Vateria indica</i> (White dammar) and their mass multiplication through tree nursery.	Oct. 2020	Oct. 2021

### 7. Approved New Sub-Project:

Sl. No	Projects	Start Date	Date of Completion
1.	Value addition of Gum-Oleoresins from <i>Ailanthus triphysa</i> (Dennst) Alston.	April 2021	April 2022
2.	Documentation of the phenology of Gum and resin yielding trees of Western Ghats	Jan. 2021	Dec. 2022
3.	Effect of ethephon treatment in both black dammar ( <i>Canarium strictum</i> ) and white dammar ( <i>Vateria indica</i> )	Dec. 2021	Dec. 2022

### Recommendations:

- The performance of dammar based *agarbatti*/cone *dhoop* developed at the centre need to be compared with commercially available products before their commercialization.
- Availability of trees need to be taken into consideration before taking new project for resin production from new species (*Bombax sybaa* and *Vetenica chinesis*)

## ICAR-CAFRI, Jhansi

1.	Centre Name	ICAR-CAFRI, Jhansi
2.	PI Name	Dr. Rajendra Prasad
	Co-PI Names	Dr. AK Handa Dr. B Alam Dr. Ramesh Singh
3.	Names of Other Technical and Non-Technical Staff Working	Dr. Ashok Shukla, RA Mr. Prashant Singh, SRF
4.	Budget Provision for the Current Year	₹14.5 Lakh
5.	Money Spent in the Current Year	₹ 13.55 Lakh

### 6. On-going Sub-Projects:

Sl. No.	Projects	Start Date	Date of Completion
1	Productivity of gum yielding tree based agroforestry models	February, 2009	Long term
2	Demonstration and development of gum yielding tree based agroforestry models on farmer's fields	April, 2009	Long term
3	ITK on gum and resin's tapping, applications and post-harvest value addition	April, 2017	March, 2022
4	Standardization of gum tapping techniques	April, 2020	March, 2023
5	Studies on root distribution pattern and above- & below-ground biomass in <i>Acacia senegal</i>	April, 2020	March, 2025

### 7. Approved New Sub-Project: NIL

### **Recommendations:**

- Centre need to publish bulletin on the Agroforestry Models developed having gum/resin producing trees for distribution to KVKs, Forest Departments, AICRP on Agroforestry for extension of the developed models.
- Bill hook developed at the centre for gum tapping from *palas* tree should be multiplied and distributed among the farmers for their feedback.
- Revenue generated under the Network Project at the centre through sales should be included while reporting.
- Methodology/technique of identification of gum by farmers in the region should be reported and documented.

## ICAR-IINRG, Ranchi

1.	Centre Name	ICAR-IINRG, Ranchi
2.	PI Name	Dr. N Prasad
	Co-PI Names	Dr. SC Sharma Dr. VD Lohot Er. S. K. Pandey Dr. AR Chowdhury Dr. NandkishoreThombare Er. Priyanka Sakare
3.	Names of other Technical and Non-Technical staff working	Er. Sravan Kumar (RA) Er. Anmol kumar Mishra (SRF) Dr. UshaKumari(SRF) Mr. Rohitkumar Pandey(SRF)
4.	Budget provision for the current year	₹ 34.00 Lakh
5.	Money spent in the current year	₹ 17.33 Lakh

### 6. On-going Sub-Projects:

Sl. No	Projects	Start Date	Date of completion
1.	Preparation and characterization of modified guar gum nanocomposite films reinforced with piyar AgNPs for diversified applications	2019	March, 2022
2.	Exploration and preparation of field guide for minor gum and resin producing plants in India	2018	March, 2023
3.	Effect of tapping techniques on gum yield from <i>Moringa oleifera</i> trees	2018	Dec., 2021

### 7. Approved New Sub-Project:

Sl. No	Project	Start Date	Date of Completion
1	Effect of Tapping Techniques on Gum Yield from <i>Buchanania lanzan</i> Trees	January, 2022	December, 2023

### Recommendations:

- New project need to be focused on developing products from gum/resin of commercial importance.
- Centre should work on the development of suitable equipment for production and processing of gums/resins

**Annexure – I**

List of participants present in 13<sup>th</sup> Annual Workshop of Network Project on HPVA of NRGs held during **November 09-10<sup>th</sup>, 2021 via Online Virtual Platform**, in different sessions:

<b>Sl. No.</b>	<b>Participants</b>	<b>Organization</b>
1.	Dr. S. K. Chaudhari	DDG (Engineering), ICAR, Delhi
2.	Dr. K.K. Singh	ADG (Farm Engineering), ICAR, Delhi
3.	Dr. K. K. Sharma	Director, ICAR- IINRG, Ranchi
4.	Dr. N. Prasad	Project Coordinator, ICAR-IINRG, Ranchi
5.	Dr. M. F. Ansari	ICAR-IINRG, Ranchi
6.	Dr. Somen Ghosal	ICAR-IINRG, Ranchi
7.	Dr. S. C. Sharma	ICAR-IINRG, Ranchi
8.	Dr. Nandkishore Thombare	ICAR-IINRG, Ranchi
9.	Dr. A. R. Choudhary	ICAR-IINRG, Ranchi
10.	Dr.V. D. Lohot	ICAR-IINRG, Ranchi
11.	Dr. N. K. Sinha	ICAR-IINRG, Ranchi
12.	Dr. Sakharam Kale	ICAR-IINRG, Ranchi
13.	Er. Pradhosh Kr. Paramguru	ICAR-IINRG, Ranchi
14.	Dr. Jamkhokai Mate	ICAR-IINRG, Ranchi
15.	Er. Shravan Kumar	ICAR-IINRG, Ranchi
16.	Mr. Rohit Kumar Pandey	ICAR-IINRG, Ranchi
17.	Mr. Anmol Kumar Mishra	ICAR-IINRG, Ranchi
18.	Dr. Usha Kumari	ICAR-IINRG, Ranchi
19.	Dr. Achintya Paramanik	ICAR-IINRG, Ranchi
20.	Mr. Sandeep Kumar	ICAR-IINRG, Ranchi
21.	Dr. Archana Verma	ICAR-CAZRI, Jodhpur
22.	Dr. Saurabh Swami	ICAR-CAZRI, Jodhpur
23.	Dr. Kamlesh Pareek	ICAR-CAZRI, Jodhpur
24.	Dr. S. Patel	IGKVV, Raipur
25.	Dr. Pratibha Katiyar	IGKVV, Raipur
26.	Er. P. S. Pisalkar	IGKVV, Raipur
27.	Er. Pooja Sahu	IGKVV, Raipur
28.	Dr. Moni Thomas	JNKVV, Jabalpur
29.	Dr. Niraj Tripathi	JNKVV, Jabalpur
30.	Mr. Ahsan Ali Khan	JNKVV, Jabalpur
31.	Mr. Zakir Husaain	JNKVV, Jabalpur
32.	Mr. Umashankar Prajapati	JNKVV, Jabalpur
33.	Dr. R. B. Kshirsagar	VNMKV, Parbhani

34.	Dr. B. A. Jadhav	VNMKV, Parbhani
35.	Dr. Preeti Thakur	VNMKV, Parbhani
36.	Dr. A. Balasubramanian	TNAU, Coimbatore
37.	Dr. C. N. Hari Prasath	TNAU, Coimbatore
38.	Mr. V. Manimaran	TNAU, Coimbatore
39.	Ms. G. Swathiga	TNAU, Coimbatore
40.	Mr. Thiru Moorthy	TNAU, Coimbatore
41.	Dr. Bhupender Dutt	Dr. YSPUH & F, Solan
42.	Dr. Rajneesh Kumar	Dr. YSPUH & F, Solan
43.	Dr. Meenu Sood	Dr. YSPUH & F, Solan
44.	Dr. Heena	Dr. YSPUH & F, Solan
45.	Dr. S Gopakumar	KAU, Thrissur
46.	Mr. Sajith M.S	KAU, Thrissur
47.	Dr. Rajendra Prasad	ICAR- CAFRI, Jhansi
48.	Dr. Badre Alam	ICAR- CAFRI, Jhansi
49.	Dr. A. K. Handa	ICAR- CAFRI, Jhansi
50.	Dr. Ashok Shukla	ICAR- CAFRI, Jhansi
51.	Mr. Prashant Singh	ICAR-CAFRI, Jhansi

## (Detailed Proceedings)

**Proceedings of the 13<sup>th</sup> Annual Workshop of Network Project on *Harvesting, Processing and Value Addition of Natural Resins and Gums* (NP-HPVA of NRGs), November 09-10<sup>th</sup>, 2021**

The 13<sup>th</sup> Annual Workshop of Network Project on *Harvesting, Processing and Value Addition of Natural Resins and Gums* (NP-HPVA of NRGs) was held during November 09-10, 2021 via Virtual Online Platform (Co-ordinated by lead Centre ICAR- IINRG, Ranchi) to review the annual progress of the Network Project centres and to discuss the technical programmes for the year 2022-23.

The meeting started with the welcome address by Dr. Niranjana Prasad, Project Coordinator of Network Project on HPVA of NRGs followed by felicitations of the dignitaries present on the Virtual Platform.

Dr. N Prasad presented the Coordinator's Report and ATR on recommendations of 12th Annual Workshop. He also presented an overview of the Network Project and briefed the objectives of the Project and also the number of methodologies/techniques, process/products, and technologies/patents developed or transferred by the PIs of Network Project to the interested farmers/stakeholders.

Dr. S. K. Chaudhari, DDG (Engineering), ICAR, Delhi and Chief Guest on the occasion delivered the presidential address. In his address, he emphasized the social and economic importance of NRGs from the medieval era (Vedic period). He further emphasized for documentation of the technologies and products developed by the centres in form of bulletin/booklets/folder etc. and sent to the Council. A plan of action for the project should be developed with realistic targets and a timeline including a commercialization plan for developed technologies/products.

The inaugural session was also addressed by Dr. K.K. Singh, ADG (Farm Engineering) and Dr. K.K. Sharma, Director, ICAR-IINRG, Ranchi.

During the Inaugural Session following product/publications of different centres under the Network Project were released by the dignitaries in virtual mode.

- Technical bulletin on वाणिज्यिक रूप से महत्वपूर्ण प्राकृतिक राल एवं गोंद , ICAR-IINRG, Namkum, Ranchi. (Jharkhand)
- Technical folder on प्राकृतिक राल एवं गोंद के संग्रहण, प्रसंस्करण एवं मूल्यसंवर्धन पर आधारित नेटवर्क परियोजना: भूमिका एवं उपलब्धियां, ICAR-IINRG, Namkum, Ranchi. (Jharkhand)
- Technical folder on **All India Network Project on Harvesting Processing and Value Addition of Natural Resins and Gums: Role and Achievement**, ICAR-IINRG, Namkum, Ranchi. (Jharkhand)
- **Mid Term Review Report** of All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums, ICAR – IINRG, Ranchi, (Jharkhand)
- Technical bulletin on **Economic analysis of gum Arabic (*Acacia Senegal* (L.) Willd.) based agroforestry model for smallholder farms**, ICAR-CAFRI, Jhansi (Uttar Pradesh)
- Booklet on **Tamarind seed gum varieties, technologies, value –addition & commercialization**, TNAU (Tamil Nadu)
- Technical folder on **Role of partially hydrolyzed guar gum (PHGG) in food processing and value addition.**, VNMKV, Parbhani (Maharashtra)
- Technical folder on गुग्गुलु सतत विदोहन चंत्र: Jawahar guggul blazer (in Hindi), JNKVV, Jabalpur (Madhya Pradesh)
- Technical folder on Guggul tapping protocol, JNKVV, Jabalpur (Madhya Pradesh)
- Technical folder on Jawahar Nutra laddu, VNMKV, Parbhani (Maharashtra)

## **Technical Session**

After the inaugural session and the remarks of the dignitaries, PIs & Co-PIs of the Network Project centres presented the progress for the year 2020 - 21 and technical programme for the year 2022–23 in the Technical Sessions Chaired by Dr. K. K. Singh, Chairman, ADG (Engineering) at ICAR, Delhi, and Co-chaired by Dr. K. K. Sharma, Director, ICAR-IINRG, Ranchi.

### **ICAR-CAZRI, Jodhpur (Rajasthan)**

Dr. Archana Verma, Scientist & PI presented the progress. PI reported that structural traits (average tree height and GBH) and gum yield of well-known gum-producing trees like *A. Senegal* (Nigerian) and *P. cineraria* were recorded. *A. Senegal* (Nigerian) has reported a higher gum yield compared to other tree species. An experiment on gum exudation was also conducted in lesser-known gum-producing trees like *P. juliflora* and *A. subrosa* where *A. subrosa* gave a higher gum yield of 179.2 g/tree. Gums obtained from above mentioned lesser-known gum producing trees species can be used for various agricultural and non-agricultural purposes.

She highlighted that farmers of 48 villages from 5 districts of Rajasthan adopted gum-inducing technology for gum production from trees like *A. senegal*, *A. tortilis*, *A. nilotica*, *A. leucophloea*, *Prosopis cineraria*, *P. juliflora*, *Anogeissus rotundifolia*, etc. and earned revenue of Rs. 52.16 lacs as gum—inducing technology of gum production was effective.

A stand of high gum yielding plant type of *A. senegal* (Nigerian origin) was established on CR farm of CAZRI during the monsoon season of 2010. The survival after 11 years was more than 96%. She also reported that farmers can cultivate vegetable crops in shaded and half-shaded *Acacia senegal* plantation stands having irrigation facilities and can earn additional revenue.

*A. senegal* and *A. tortilis* gum-based micro encapsulated powders were characterized by FTIR and particle size analysis. *A. Senegal* gum and *A. tortilis* gum as wall materials were successful in micro encapsulating the anthocyanin.

Various types of gum *Arabic* and *B. monosperma* gum-based value-added products were processed for standardization and gum *Arabic* based sweets/confectionery products and mouth fresheners were prepared and with the help of hedonic scale the product taste and other parameters were tested. She highlighted that centre has developed *Butea monosperma* gum based crack healing cream which does not possess any side effects.

### **Recommendations:**

- ATR on recommendations of the 12<sup>th</sup> Annual Workshop needs to be revised.
- Centre should discontinue very long projects.
- New project need to be oriented to address the complete value chain of the commercially important major/minor gums of arid region.
- Centre should develop method/technique for identification of gums of arid region to check adulteration.

### **IGKV, Raipur (Chhattisgarh)**

Dr. Pratibha Katiyar, Professor & Co-PI and Dr. Prashant S. Pisalkar, Assistant Professor & Co-PI presented the progress w.r.t. production and gum processing respectively. They reported that *Palash* trees can be tapped in winter as well as in summer for gum production and mechanical method of tapping with an axe was found to be quite effective but its collection is still a problem due to its more fluidity. They also reported that electron dispersive spectroscopy (EDX) carried out to detect the elements present at the surface of a particular area of *Palash* (*Butea monosperma*) and found presence of Ca, Mg, K, Zn, Cl, As, Cd, Mn and Al and elements, Ca, Mg and K presented as high concentrations while Zn and Cl presented moderate amount with traces of Cd and Mn. Thermogram of *Palash* (*Butea monosperma*) shows the exothermic peak at around gum 200°C.



They further reported that  $\text{NaHCO}_3$  was not found suitable for dehusking of *cassia tora* (Charota) seeds but KOH and NaOH partially dehusked cassia tora (Charota) seed from endosperm/gum layer in all concentrated alkali solution where as HCl (0.50% concentrated solution) removed husk from *cassia tora* (Charota) seed with thumb pressure and with millet dehusker sample was passed up to two times, but it was observed that partially, husk and gum layer was separated from endosperm. In millet polisher, dried seed samples were kept in the polisher for different periods (*i.e.* 10, 15, and 20 min) but sample was nearly dehusked and still some gum layer was adhered with seeds. Attrition mill divided the seeds into two halves but attached husk and gum layer was not separated. It was also observed that gum yield ranged from 3.97 to 5.62% which was very less.

They reported that in Rohini (*Soymida fembrifuing Roxb*), temperature and RH play a significant role in exudation and single cut traditional method of gum tapping was effective in this tree for gum tapping and use of gum enhancers was found to be significantly superior to the traditional method. In case of Saja (*Terminalia tomentosa*) and Chironji (*Buchanania lanzan Roxb.*) gum enhancers application was found to be significantly effective and summer season of tapping shows a significantly higher rate of gum exudation as compared to the winter season.

to induce higher gum production compared to the use of battery-operated drill machine.

### **Recommendations:**

- Centre should reconfirm presence of heavy metals in tapped gums before reporting.
- Final recommendations of gum tapping methods for *karaya*, *ghatti*, *saja* and *chiraunji* need to be prepared and published for adoption.
- New project need to be oriented to address the complete value chain of the commercially important assigned to the centre.
- Effort should be made to commercialize the gum based extruded products developed by the centre.

### **JNKVV, Jabalpur (MP)**

Dr. Moni Thomas, Professor & PI presented the progress. PI reported that four packing/containers *viz.* earthen pot, plastic jar, polythene bag, and jute bag were used to store fresh *guggul* gum (250 g each) and stored at room temperature. The stored *guggul* samples in different packing/containers were analyzed by liquid chromatography-Mass Spectrometry and found that molecular weights of different compounds eluted at different retention times (RT) and variations among the molecular weights of compounds indicated vital role of storage containers and age of *guggul* gum resin. He reported that maximum numbers (19) of compounds have been eluted from the *guggul* sample stored in earthen pot compared to plastic jar (14), polythene bags (13) and Jute bags (13).

He also reported that shelf life of Jawahar Guggul Laddu (JGL) was analyzed for its qualitative parameters and found that fresh JGL had a calorific value of 482.23 Kcal/100g which reduced by 1.73 and 5.44% and total carbohydrate content reduced by 14.15 and 28.3% after 30 days and 60 days, respectively. Loss of fat (6.46%) and protein (7.5%) was less after 30 days over that in fresh JGL but more loss by 23.1 and 24.17% respectively after 60 days. He further reported rapid loss of minerals during storage.

### **Recommendations:**

- New project need to be focused to address the complete value chain of the *guggul*.
- New project proposal should be submitted in RPP-I format.

- Reanalyze the experimental data related to change in *guggul* essential oil content during storage.

### **VNMKV, Parbhani (Maharashtra)**

Dr. R. B. Kshirsagar, Professor & PI presented the progress of the centre. PI reported that tannin content of guar korma meal was examined by different processing methods, where the autoclaving and extrusion showed a higher reduction in tannin content of 78.23% and 82.08% respectively. The lowest reduction was observed in the soaked sample 46.24%.

He also reported that incorporation of 15% partially hydrolyzed guar gum in instant tomato soup powder improved the flowability, reconstitution properties, solubility, water solubility index, and wettability along with an increased insoluble dietary fiber. The instant tomato soup powder can be safely stored up to 90 days in the refrigerated condition in polypropylene packaged pouches. Use of guar meal can replace up to 40% potato starch in the casting solution as well as in edible film. The addition of guar meal and PHGG along with plasticizers had good mechanical, barrier, and film-forming abilities. Effect of prepared casting solution as a coating material for plum fruits revealed that shelf life extended up to 14 days as compared to uncoated fruits without affecting their sensory attributes. The soy meal can be replaced up to 12% with protein-rich guar meal korma in poultry feed ration and found to be acceptable for poultry birds.

### **Recommendations:**

- Centre should compare the products developed with commercially available products w.r.t. quality, shelf life, cost etc. before commercialization.
- Before taking new project, previous work carried out need to be thoroughly reviewed and published in form of review / status paper.
- Centre should focus on taking new project targeting to enhance the value of guar gum/ by products of guar gum industries.
- Work related cultivation of guar is not covered under the objective of the Network Project. Accordingly, centre need not to propose guar cultivation related project under this Network Project.

### **TNAU (Tamil Nadu)**

Dr. A. Balasubramanian, Professor & PI presented the progress. PI reported that in 5 tamarind germplasm planted, Hasanur 06 sprayed with foliar application of Paclobutrazol 500 ppm has shown maximum flowering in tamarind but Hasanur 06 and PKM 1 showed maximum fruiting percentage.

On basis of value for chlorophyll contents (Chlorophyll 'a', chlorophyll 'b', total chlorophyll, and chlorophyll a/b ratio), it was concluded that application of Paclobutrazol (500 ppm) recorded highest chlorophyll contents in three growth stages and lowest in (Control).

He also reported that total 11 species of insect pests and 3 species of natural enemies documented both in the tamarind plantation and seed storage out of which three species of sucking pests, fruit borers and seed borers/kernel powder feeder and two species of defoliators were documented in tamarind plantation. Natural enemies include two species of spiders and a praying mantids. Potential pollinators of tamarind viz., Apisfloreana, Apisdorsata, Apiscerana, Amegillazonata, Trigonasp, Xylocopa sp., Camponotus sp., Sarcophaga sp., Certinahieroglyphica were visited during the peak period of flowering.

The gum inducer dosage of 400 mg/ml of ethephon concentration and 1.2% H<sub>2</sub>SO<sub>4</sub> concentration was found to be significantly superior in gum production over other treatments in *Chloroxylonswietenia*, *Pterocarpus marsupium*, and *Butea monosperma*. He further reported that diameter class of 60-90 cm was found to be superior to other diameter classes in terms of gum production. In case of *Moringa oleifera*, a maximum gum yield 42.80 g was observed with hand drilling and application of 4 ml gum

inducer application and minimum with mechanical drilling without gum inducer in diameter class 90-120 cm under non-irrigated condition, whereas in irrigated conditions, maximum yield (102.20 g) was observed followed by (84.60, 63.20, and 57.10 g) whereas minimum with gum yield of 17.90 g in diameter class of 90-120 cm. Within the span of 3 months observation, the diameter class of 90-120 cm produced more gum than the diameter class of 30-60 cm and 60-90 cm.

### **Recommendations:**

- The experiment of gum tapping from moringa (*Moringa oleifera*) should be continued for the next 2 – 3 years to know the effect of gum inducer (ethephon)
- Centre should focus on taking new project targeting to enhance the value of TKP/ by products of TKP industries.

### **Dr. YSPUH & F, Solan (HP)**

Dr. Bhupender Dutt, Professor & PI presented the progress of the centre. PI reported that anatomical characteristics in *Pinus roxburghii* Sargent were determined and maximum number of resin ducts (1.17/mm<sup>2</sup>) was observed in diameter class D4 (>60 cm) and minimum number of resin ducts was 0.86/mm<sup>2</sup> noticed in diameter class D1 (30-40 cm). He also reported that maximum tracheid length (4.12 mm) and tracheid diameter (0.077 mm) observed in diameter class D4 (>60 cm) whereas, minimum tracheid length (3.09 mm) and tracheid diameter (0.51 mm) was noticed in diameter class D1 (30-40 cm) and D2 (40-50 cm), respectively. Maximum ray height (0.45 mm) was observed in diameter class D3 (40-50 cm) and minimum ray height (0.025 mm) noticed in diameter class D1 (30-40 cm). Maximum (0.050 mm) and minimum ray width (0.023 mm) noticed in diameter class D4 (>60 cm) and D1 (30-40 cm), respectively and maximum frequency/number of medullary rays (37.10/mm<sup>2</sup>) was found in diameter class D4 (>60 cm) and a minimum (27.93/mm<sup>2</sup>) recorded in diameter class D1 (30-40 cm).

He further reported that to determine anatomical characteristics, *Chir Pine* trees were marked and wood samples at breast heights were collected and maximum ray length (0.439 mm) recorded in progeny Kaldoo P4 and minimum (0.188 mm) noticed in Dibkon P3 progeny. Maximum (0.045 mm) and minimum ray width (0.018) observed in Kaldoo P4 and Leda P5 progenies, respectively. Maximum (37.10/mm<sup>2</sup>) and a minimum number of rays (27.04/mm<sup>2</sup>) were found in Kopra P5 and Kaldoo P9, respectively. Maximum tracheid diameter (0.085 mm) observed in Kopra P5 and minimum (0.049 mm) noticed in Rakni P8 and Kather PT Black Centre.

He informed the house that borehole method of oleoresin tapping was demonstrated to the Range Forest Officer trainees of the State Forest Department of Himachal Pradesh during the last year to promote resin production through bore hole method.

### **Recommendations:**

- Centre should find out the reason for maximum resin production with 40<sup>0</sup> angled boreholes as reported.
- Diameter classes of the trees selected for resin tapping experiments with borehole and rill method should be the same for comparison.
- A standardized protocol for resin tapping should publish in form of bulletin, booklet, paper, etc.
- Subprojects should be formulated for the next five years considering the objective and mandate of the Network Project and project related to application development and value addition of rosin need to be taken.

### **KAU, Thrissur (Kerala)**

Dr. S. Gopakumar, Professor & PI presented the progress. PI reported that size and shape of dhoop cones were standardized based on the market trends, fume production and ease of making. Height and

diameter of dhoop cone were selected as 2.5 and 1.2 cm, 2.5 and 1.8 cm, 3.5 and 1.5 cm and 3.5 and 1.8 cm, respectively and made using different compositions of pre-mix powder and black dammar for studying the burning duration. Different compositions consisted of pre-mix powder and black dammar powder at 1:1 ratio, 1:0.75 ratio and 1: 0.50 ratios and prepared using paper and mild steel moulds. Burning duration of dhoop cones were estimated by burning the cones placed on cardboard in a well-ventilated room. As part of value addition of black dammar, the size and composition of the Dhoop cones were standardized and the commercial production has been started in the production centre attached to the College of Forestry. The training for production of dhoop cones using the moulds was also imparted to tribals.

Machine for commercial production of incense sticks was developed consists of foot pedal, pawl and ratchet mechanism, piston-cylinder arrangement, chain drive, rack and pinion system and an extruder. Agarbatti making unit attached to College of Forestry was renovated and upgraded into a Production and Training centre to conduct training programs on manual and mechanical ways of agarbatti making. Developed machine can manufacture 20 to 30 incense sticks per minute.

The centre at College of Forestry conducted several outreach programmes on sustainable harvesting and value addition of black dammar including making of black dammar incense sticks at different tribal settlements in Kerala. The training was imparted to tribals in scientific harvesting of dammars and agarbatti making.

### **Recommendations:**

- The performance of dammar based *agarbatti/* cone *dhoop* developed at the centre need to be compared with commercially available products before their commercialization.
- Availability of trees needs to be taken into consideration before taking new project for resin production from new species (*Bombax sybaa* and *Vetenica chinesis*).

### **ICAR-CAFRI, Jhansi (UP)**

Dr. Rajendra Prasad, Principal Scientist & PI presented the progress. PI reported that during summer season 2020, natural exudation of gum in different fields of *A. Senegal* was observed and gum yield ranged from 11.34–133.24 g/tree in agri-horti-silviculture model (average: 61.76 g from 6 trees), 1.51–110.0 g/tree in rainfed agri-silviculture model (average: 33.15 g from 21 trees), 0.73–104.43 g/tree in old gum garden (average: 22.21 g/tree from 13 trees), 1.92–177.39 g/tree in new gum garden (average: 33.52 g/tree from 11 trees) and 25.82–44.25 g/tree (average: 25.00 g/tree from 7 trees) in block plantation in rocky area.

Natural exudation of gum in different fields of *A. nilotica* was also observed and gum yield ranged from 8.25–26.59 g/tree in silvi-herbal model (average: 17.57 g/tree from 5 trees) and 0.43–83.23 g/tree in rainfed agri-silviculture (average: 14.78 g/tree from 10 trees).

Survival percentage and annual growth data of *A. Senegal* based gum gardens were observed higher in *A. senegal* than *B. monosperma* in both gardens. *A. senegal*, planted in new gum garden *i.e.* during 2015, attained good girth and showed relatively higher survival (%) than that planted during 2014. Out of 190 plants of *A. senegal* in old gum garden, 31 yielded gum-arabic. Out of 268 *A. senegal* trees in the new gum garden, natural exudation of gum-arabic was observed from 23 trees.

After 11 years of planting, *A. senegal* recorded relatively more survival (up to 59.5%) than *A. nilotica* (up to 50%) at Garhkundar watershed area and at village Ambabai, 37% survival of *A. senegal* with average height of 294.5 cm and an average collar diameter of 17.5 cm was recorded.

During rainy season 2020, 4 different bio-fence models were practiced for observation of plant growth and their survival rate using single and double row method where maximum survival percentage was noticed in model-3 in *Acacia senegal*.

During rainy season 2020, approximately 35000 quality seedlings of *A. senegal* raised in the nursery at ICAR-CAFRI, Jhansi, out of which 30000 seedlings were provided to enable “Doubling Farmer’s Income (DFI)” for planting in seven districts of Uttar Pradesh. At each site, 4-5 farmers have been

identified for developing horti-silviculture, agri-horticulture, and agri-horti-silviculture models. *A. senegal* has also been planted on field boundaries as it acts as bio-fence.

A study has been started on various gum-yielding tree-based agroforestry models to assess the relation between the natural exudation of gums from *A. senegal* and *A. nilotica* with soil moisture content (%).

### **Recommendations:**

- Centre need to publish bulletin on the Agroforestry Models developed having gum/resin producing trees for distribution to KVKs, Forest Departments, AICRP on Agroforestry for extension of the developed models.
- Bill hook developed at the centre for gum tapping from *palas* tree should be multiplied and distributed among the farmers for their feedback.
- Revenue generated under the Network Project at the centre through sales should be included while reporting.
- Methodology/technique of identification of gum by farmers in the region should be reported and documented.

### **ICAR-IINRG, Ranchi**

Dr. S.C. Sharma, Sr. Scientist; Dr. Arnab Roy Chowdhury, Scientist and Dr. Nandkishore Thombare, Scientist & Co-PIs presented the progress of the centre for their respective Sub-Project being carried out at the centre. They reported that nanocomposite films reinforced with piyar-AgNPs were developed for diversified applications through solution casting method, by varying reactants *i.e.* modified guar gum (MGG), plasticizer, piyar-AgNPs, etc., to study the effect on physical, mechanical, thermal, barrier and antimicrobial properties of the resulting nanocomposite (NC) films and characterized by physical properties (thickness, opacity, color value), UV-Vis, FT-IR spectroscopy, Field Emission-Scanning Electron Microscopy (FE-SEM) and Energy dispersive spectrum (EDS) analysis and Differential Scanning Calorimetry (DSC) and mechanical properties (tensile strength, flexibility). The antifungal evaluations of developed nanocomposite films were carried against *Aspergillus niger*. Color values (L, a & b) of the developed nanocomposite films were determined and found that 'L' values increased with the increasing concentration of the nanoparticles in the films resulted the darker color films. Further, films showed negative 'a' values for greenish and positive 'b' values for yellowish color. Field emission scanning electron microscope images of the developed nanocomposite films were recorded to obtain the morphological features of the films and observed flat, dense, and homogeneous. On the other hand, SEM images of films are characterized by uniformly distributed silver nanoparticles (AgNPs) which are identified as white spots on the smooth surfaces of the nanocomposite films. FE-SEM images of the cross-section of films indicated incorporation of the AgNPs and SEM images of a cross section of films also showed uniform distribution of formed nanoparticles throughout the film thickness. The absorption peak at 20 keV in the EDS spectrum of the nanocomposite film confirms the presence of elemental Ag and the results demonstrate that 0.07% of nanoparticles formed inside the film.

DSC thermogram of the nanocomposite films was carried out and shows one endothermic peak at 85.44°C and one exothermic peak at 287.20°C which indicates loss of water and plasticizer molecules from the films and thermal degradation of the modified guar gum and plasticizer molecules in the films, respectively. DSC thermogram also indicated that onset of the thermal degradation started at 260°C and thermo stable upto 250°C. Silver nanoparticles impregnated nanocomposite films developed for the improved mechanical strength of the modified guar gum which reveals that nanocomposite film has improved mechanical strength *i.e.* tensile strength and modulus than control 45 films which indicates excellent interaction between polymer matrix and Ag nanoparticles and intermolecular forces and electrostatic force between Ag nanoparticles and polymer matrix that makes the film strengthened and shows better mechanical properties. Similarly, breaking strain or percentage of elongation is more for nanocomposite films. It was noticed that incorporation of Ag nanoparticles increases the tensile strength and makes the film more flexible. Antifungal susceptibility test for the developed nanocomposite film was done and found that fungal strain of *Aspergillus niger* was first

grown in potato dextrose liquid medium broth and incubated at 30°C for 5 days before use. Nanocomposite film showed promising antifungal activity as compared to control.

Surrounding forest areas of Ranchi, Jharkhand was surveyed during 2020-21 and photographs were taken for missing plant parts of some gum-resin trees including flowers, fruits, leaves, whole plants, and gum exudation of different plant species. Various plant parts of the trees like *Garuga pinnata*, *Spondia smombin*, *Acacia sieberiana*, *Acacia polyacantha*, *Albizia amara*, *Albizia lucidior*, *Bombax ceiba*, *Delonix regia*, *Samanea saman*, *Leucaena leucocephala*, etc. were photographed and seasons were noted. To enhance the scope of study, two centers namely KAU, Thrissur, Kerala, for photographing different plant parts of gum and resin plants of western ghats of Kerala and CAZRI, Jodhpur, Rajasthan, for arranging photographs of different plants parts of the gum-resin producing trees from the arid regions of Rajasthan were involved in the project.

Gum tapping die fabricated based on detailed manufacturing design drawing developed in Pro Engineer CAD Software in collaboration with ICAR–CIAE, Bhopal and further modified for smooth functioning of the developed gum tapping die/tool based on field evaluation trials of moringa gum tapping from *Moringa oleifera* trees at Kankebar, Ramgarh district in Jharkhand. After field evaluation trials of modified gum tapping die/tool in actual field condition for moringa gum tapping from *Moringa oleifera* trees, modified model of gum tapping die/tool further were improved to standardize the gum tapping die/tool for gum tapping from selected tree species. The stopper mechanism was included in the standardized model of gum tapping die/tool, so that depth of blaze/incision on the tree trunk may be maintained as per requirement.

### **Recommendations:**

- New project need to be focused on developing products from gum/resin of commercial importance.
- Centre should work on the development of suitable equipment for production and processing of gums/resins

### **Business Session**

After completion of the presentations, a brief session was held to discuss various issues and suggestions by the PIs & Co-PIs of the Network Project centres. The session was chaired by Dr. KK Sharma, Director, ICAR-IINRG, Ranchi and co-chaired by Dr. N. Prasad, Coordinator, All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums. Dr. N. Prasad, Coordinator, All India Network Project briefed about the discussions held during two days and also appreciated active participation of delegates in the technical session. He suggested following for better implementation of project at centres.

- All the coordinating centre should submit technical and financial report in time.
- All the coordinating centres should acknowledge ICAR for providing fund in their publications/products/technology developed.
- Budget allocated to the coordinating centres, under the project, should be fully utilized with proper planning.
- SRF Recruitment proposal of Dr. YSPUH & F, Solan (HP) and ICAR-CAZRI, Jodhpur (Rajasthan) centers agreed.
- Jawahar Guggul Laddu (JGL) may be commercialized following ICAR guidelines.
- Requirement of equipments should be included in the next SFC for procurement.

### **Concluding Session:**

The concluding session was chaired by Dr. Suresh Kumar Chaudhari, Deputy Director General (Agricultural Engineering), Indian Council of Agricultural Research, New Delhi. Dr. K.K. Singh,

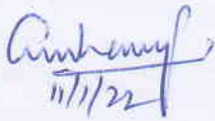
ADG (Farm Engineering) and Dr. KK Sharma, Director, ICAR- IINRG were also present in the session and gave their concluding remarks based on two days deliberations in the Workshop.

Dr. Suresh Kumar Chaudhari, Deputy Director General (Agricultural Engineering), ICAR, Delhi addressed the delegates. In his address, he emphasized that Products developed by centres under the project on commodities assigned should be documented in form of book/booklets/folder and sent to the Council. He further advised that future plan of action for the project should be developed with realistic targets and timeline including commercialization plan for developed technologies/products. He suggested to all centres under the project for developing complete package to promote gums and resins including value chain for enhancing additional income of the farmers.

Based on the deliberations in the concluding session following recommendations emerged..

- Staff requirements and fund requirements for all the cooperating centres should be taken care of by the Coordinating Unit.
- A complete value chain for assigned gums to centers should be developed.
- All centre should submit a monthly report of the project to the coordinating Unit for onward transmission to the council as per requirement.
- **Ranking the centres based on performance** need to be done every year.
- ATRs need to be revised as per suggestion.
- All centres should standardize the protocol for harvesting and collection of the assigned commodity and publish in form of bulletin.
- The new project should be submitted in RPP – I format.
- On-farm processing and value addition need to be emphasized by each centre for the assigned commodity to increase farmer's income.
- One success story in six months from each centre should be submitted to the coordinating centre.
- All centres under the project should ensure full utilization fund.

The workshop ended with a vote of thanks to the chair.



(Dr. K.K. Sharma)  
Director  
ICAR-IINRG, Ranchi



(Dr. Niranjan Prasad)  
Coordinator  
Network Project



**(Salient findings of each of the on-going Sub-projects)**

**ICAR-CAZRI, Jodhpur (Rajasthan)**

**Sub-Project 1:** Study on gum production from known and lesser-known gum producing tree species of arid zone of Rajasthan

- Structural traits (average tree height and GBH) and gum yield of well-known gum-producing trees like *A. senegal* (Nigerian) and *P. cineraria* were recorded. *A. senegal* (Nigerian) has reported a higher gum yield compared to other tree species.
- An experiment on gum exudation was also conducted in lesser-known gum-producing trees like *P. juliflora* and *A. subrosa* where *A. subrosa* gave a higher gum yield of 179.2 g/tree. Gums on these tree species can be used for various agricultural and non-agricultural purposes.

**Sub-Project 2:** Extension of gum inducing technique in arid regions of Rajasthan

- Farmers of 48 villages of 5 districts of Rajasthan adopted the gum-inducing technology on trees like *A. senegal*, *A. tortilis*, *A. nilotica*, *A. leucophloea*, *Prosopis cineraria*, *P. juliflora*, *Anogeissus rotundifolia*, etc. for gum production. This technique was effective and they earned revenue of Rs. 52.16 lacs.
- One or Two days' survey was conducted for identifying gum exudation site, gum exudation tree species, and lesser-known tree species at farmers' fields located in nearby areas.

Training/demonstration/survey of CAZRI gum exudation technology during 2020- 2021.

- Surveyed Bhopalgarh block on 26<sup>th</sup> October 2020 for identifying gum exudation site located at nearby area.
- A one-day survey of the Pali district was conducted for target sites of gum exudation tree species.
- On 2<sup>nd</sup> January 2021, survey was conducted in the Shergarh and Tiwari block of Jodhpur district for identifying lesser-known tree species clusters located at farmers' fields.
- Survey was conducted during 13<sup>th</sup>-14<sup>th</sup> January 2021 of Jaisalmer district for targeting gum exudation potential village where known gum exudation tree species found at farmers' fields.

**Sub-Project 3:** Plantation establishment, maintenance and evaluation of high gum yielding plant type of *Acacia senegal* and *Butea monosperma*.

- A stand of high gum yielding plant type of *A. senegal* (Nigerian origin) was established on CR farm of CAZRI during the monsoon season 2010. The survival percentage after 11 years was more than 96% with planting distance 6 x 3 m. Average plant height was 6.51 m, GBH was 31.63 cm and the average canopy was 4.9 m.
- Results indicated that vegetable crops can be grown with trees at farmers' fields having irrigation facilities. Farmers can cultivate vegetable crops in shaded and half-shaded *Acacia senegal* plantation stands. Farmers can gain additional revenue by cultivating vegetables in dense tree stands of *Acacia Senegal*.

**Sub-Project 4:** Evaluation of *Acacia senegal* and *Acacia tortilis* gums as wall materials for encapsulation of phytochemicals.

- *A. senegal* and *A. tortilis* gum based microencapsulated powders were characterized by FTIR, particle size analysis, anthocyanin and antioxidant content.
- *A. Senegal* gum and *A. tortilis* gum as wall materials were successful in microencapsulating the anthocyanin rich extract. The powders showed good antioxidant activity.

### **Particle size analysis**

- Average particle size obtained by Dynamic Light Scattering (DLS) was 12654 nm and 14583 nm, respectively, for the *A. senegal* and *A. tortilis* microencapsulated powders. After freeze-drying, the reconstituted emulsions were having an average particle size of 834 nm and 951.3 nm, respectively.

### **Anthocyanin content**

- Concentrations of anthocyanins as the core material of *A. senegal* and *A. tortilis* gum microencapsulated powders were determined. Anthocyanin content in mg cyanidin-3-glucoside equivalent per 100 g of the powders was 64.8 and 59.4, respectively. This shows that both the wall materials were able to successfully encapsulate anthocyanins.

### **Antioxidant activity**

- The antioxidant activity of the microencapsulated powders in terms of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity is presented. The samples of *A. senegal* and *A. tortilis* gum powders showed comparable DPPH radical scavenging activity of 42.5 and 38.8%, respectively. Thus, both the microencapsulated powders retained the antioxidant activity of the core material.

### **Sub-Project 5: Value addition of gum arabic through convenient technology**

- Various types of gum arabic and *B. monosperma* gum based value added products were processed for standardization.
- Gum arabic based sweets/confectionary products and mouth freshener prepared and tested for overall mixture of all flavors of processed products with gum arabic in relation to taste, size and other parameters based on hedonic scale.
- *Butea monosperma* gum based crack healing cream was prepared which does not possess any side effects.

## **IGKV, Raipur**

### **Sub-Project 1: Sustainable utilization of gum and resin by establishing improved tapping technique in Dhawara/Ghatti (*Anogeissus latifolia*)**

- In dhawara, rate of gum exudation was significantly superior in May over other months and use of gum enhancers was found to be significantly effective over traditional tappings in dhawara.
- Tapping at ½ DBH, 1 DBH, and 1½ DBH was compared based on gum production on more than one diameter tree denotes that 1 DBH was found to be most appropriate for the highest gum production.
- Dhawara tree species can be tapped throughout the year except for the rainy season. Winter tapping can be done via the combined effect of ethephon and H<sub>2</sub>SO<sub>4</sub> (5.5% ethephon+10% sulphuric acid).
- Summer season created stress due to high temperature and low RH% and higher conc. of ethephon @ 5.5% (4 ml) injected at the single hole made by hand girit was found significantly effective to induce higher gum production compared to use of battery operated drill machine for enhanced gum production with nail size 10.00 mm and depth 2-3 cm.

### **Sub-Project 2: Sustainable utilization of gum and resin by establishing improved tapping technique in Sal (*Shorea robusta*) and Salai (*Boswellia serrata*).**

- Double V shape cut at one DBH (2 cm deep) more than 90 cm diameter tree was found best amongst all mechanical and traditional tapping.

- Use of gum enhancer *i.e.* combined effect of ethephon @ 3.9% +Sulfuric acid10%) applied with making a hole by hand girit and injected gum enhancer was found to be superior over mechanical and traditional method of tapping.
- Solubility of salai gum was found more in organic solvents acetone and ethanol indicated the availability of more resin content in exudates.
- Physio-chemical properties of gum tapped by mechanical, traditional, and using gum enhancers indicated that there was a non-significant difference in their properties of gum in moisture content, ash content, protein and nitrogen content, viscosity, solubility, and pH value. Tannin and phenol content slightly increased with the use of gum enhancers in the exudate of salai.
- Microstructure at SEM (Scanning electron microscopy) analyzed for element composition using EDX system indicated that Ca, K, and Mg were the major elements of salai gum and observed that in mechanically tapped gum having Mn, Si, and Cr, additionally while in gum enhancer tapped gum having K and Fe in 35 gum sample in salai (*Boswellia serrata Roxb.*) However, remaining Ca, Mg, Cu, Ni, Al, and Cl were same.
- Surface area of dhawda (*Anogeissus latifolia*) and chironji (*Buchanania lanzan Spreng.*) were sharp lucent crystalline flanks having more surface area related to more hydrophilicity as compared to Salai (*Boswellia serrata Roxb.*) gum (Polyhedral flanks).
- DSC (Differential scanning calorimetry) study of three gums were analyzed by making a thermogram and indicated that salai gum has more enthalpy as compared to dhawada and chironji gum. The exothermic peaks obtained at around 200°C in salai while it was obtained below 150°C in dhawda and chironji.
- Thermogram of salai (*Boswellia serrata Roxb.*) gum shows the exothermic peak at around 200°C.

**Sub-Project 3:** Development of tapping techniques for sustainable extraction of biopolymer in Rohini (*Soymida febrifuing Roxb*), Chironji (*Buchanania lanzan Spreng*) and Saja (*Terminalia tomentosa Roxb.*)

- In rohini (*Soymida febrifuing Roxb*), temperature and RH play a significant role in exudation and single cut traditional method of gum tapping was effective for gum tapping purposes and use of gum enhancers in gum tapping from rohini (*Soymida febrifuing Roxb*) was found to be significantly superior over traditional method of tapping and ethephone application @ 5% (4 ml) applied at single and triple places on the stem at 1 DBH was almost equally effective. Hence, it can be applied at single place for higher production of gum.
- In case of chironji (*Buchanania lanzan Spreng*) all experimental trees were treated with gum enhancers and traditional method (single cut with the axe) and exudation started within a week and continues throughout the season summer (March to June) and winter (January to February) in both the experimental year 2019-20 and 2020-21. In the comparative study on tapping season (summer and winter) it was observed that summer season of tapping shows a significantly higher rate of gum exudation as compared to the winter season of tapping.
- Gum can be tapped throughout the year from rohina, chironji and saja trees using gum enhancers but summer season with low humidity and high temperature is quite favorable for gum tapping.
- Ethephone 3.9% applied at three places on a tree trunk at 1 DBH was found to be significantly effective in rohina and in saja 2% H<sub>2</sub>SO<sub>4</sub> at triple places. While the combined affect of ethephone @5.5%+ 10% H<sub>2</sub>SO<sub>4</sub> was quite effective in chironji over traditional and other mechanical methods.
- Use of gum enhancers slightly changes the physico-chemical properties *i.e.* pH, acid insoluble ash (AIA) and swelling index (decreased), hydrophobic protein, tannin, alkaloid, and ash

content (increased), crude fat and fiber (not affected) as compared to traditionally tapped gums.

- DSC denotes that use of gum enhancer not influence the major elements of gum Ca, Mg & K as compared to traditionally tapped gum and TGA analysis indicated that excrete the experimental trees shows the presence of volatile compounds, polymer and carbon block and at 510°C have ash (silica and ZnO<sub>2</sub>).
- In saja (*Terminalia tomentosa*), ethephon @3.9% applied at a single place was found to be significantly effective to enhance the gum production compared to other treatments when applied at a single place and use of gum enhancers was found to be superior to the traditional method of tapping.

**Sub-Project 4:** Studies on extraction of gum from charota (*Cassia tora*) seeds and its characterization.

- In case of charota (*Cassia tora*), NaHCO<sub>3</sub> treatment was not found suitable for deshushing cassia tora (charota) seeds, KOH and NaOH treatment partially dehusked *cassia tora* (charota) seed in all concentrated alkali solution and HCl treatment (0.50% concentrated solution) removed husk from *cassia tora* (charota) seed with applied thumb pressure.
- In millet dehusker sample passes up to two times but it was observed that partially husk and gum layer was separated from endosperm. In millet polisher, dried seed samples were kept in the polisher for different time period (10, 15 and 20 min) but it was observed that the sample is nearly dehusked but still some gum layer adhered after some time throughout with husk layer. Attrition mill was not found suitable for separation of husk and gum layer from seed but divided the seeds in two halves. Charota seed yielded 3.97 to 5.62% gum which was very less.

**Sub-Project 5:** Development of scientific harvesting and collection of Palash (*Butea monosperma*) gum, Kamarkas.

- Study indicates that gum from Palash tree can be tapped in winter as well as in summer with axe (semi arc) which was found quite effective but its collection is still a problem due to its more fluidity.
- Elemental analysis: Electron dispersive spectroscopy (EDX) was carried out to detect the elements present at the surface of a particular area of Plash (*Butea monosperma*). Ca, Mg, K, Zn, Cl, As, Cd, Mn and Al are present in Plash with high concentrations of Ca, Mg and K while moderate amount of Zn and Cl was observed and Cd and Mn presented only some trace. Thermogram of Plash (*Butea monosperma*) showed exothermic peak at around gum 200°C.

## **JNKVV, Jabalpur**

**Sub-Project 1:** Comparative Liquid Chromatography Mass Spectrometry analysis of *guggul* gum in storage.

- Under the study, four packing/containers *viz.* earthen pot, plastic jar, polythene bag and jute bag were used to store fresh *guggul* gum (250 g each container) at room temperature and analyzed using Liquid Chromatography Mass Spectrometry which resulted molecular weights of different compounds eluted at different retention time (RT) with variations and indicated vital role of storage containers and age of *guggul*.
- Maximum numbers (19) of compounds have been eluted from the *guggul* sample stored in earthen pot with least number of compounds in other containers plastic jar (14) and polythene bags and jute bags (13).

**Sub-Project 2:** Effect of wall thicknesses of earthen pots on quality of stored *guggul*.

- Shelf life of Jawahar Guggul Laddu (JGL) was analyzed for its qualitative parameters. Fresh sample of JGL was compared with those stored in room temperature for 30 and 60 days in the laboratory and analyzed from NABL accredited laboratory in Jabalpur. Fresh JGL had calorific value of 482.23 K cal/100g which reduced 1.73 and 5.44% after 30 and 60 days. Similarly, total carbohydrate content reduced by 14.15 and 28.3%, respectively after 30 and 60 days. Loss of fat (6.46%) and protein (7.5%) was less after 30 days over that in fresh JGL but more loss by 23.1 and 24.17%, respectively after 60 days. Rapid loss of minerals was observed during storage.

**Sub-Project 3:** Assessment of the effects of moisture on quality of *guggul* stored in earthen pots.

- To evaluate the superiority of earthen pot among the four containers, fresh *guggul* gum was stored in two different earthen pots out of which one earthen pot was kept in moist sand bath and second was wrapped with moist old jute bag for a year. The LC-MS of stored *guggul* samples showed a total of twenty compounds with different retention time eluted in the sample stored in the earthen pot wrapped with moist jute bag in comparison to just from that stored in the earthen pot in moist sand bath.

**Sub-Project 4:** LC/MS analysis of *guggul* gum of different age.

- LC-MS analysis of *guggul* samples collected during the years 2016, 2018 and 2019 stored in earthen pots was done which revealed compounds of varying molecular weights and retention time in the samples of different age of storage. Maximum variation was observed between the *guggul* samples collected during the year 2016 and 2018 and it was minimum in samples between 2018 and 2019.

**Sub-Project 5:** Guggul nursery and large scale plantation.

- Nursery raising and plantation was done by Sujagriti Samaj Sevi Sanstha, Morena. NGO-Sujagriti Samaj Sevi Sanstha, Morena adopted the technique of identification of good *guggul* seeds and nursery preparation developed by the Project. Till date, the NGO (Sujagriti Samaj Sevi Sanstha) has raised over 52000 *guggul* seedlings out of which 42,000 seedlings transplanted in Madurai while remaining in Morena through community participation.

**Sub-Project 6:** Survey of gum yielding plants of local importance.

- Survey was conducted in the forest areas of different districts (Pohri tehsils, South Kuno Forest, Shivpuri) to collect information on gum yielding plants of local importance and observed that local people collects gums from *Kardahi*, *Dhawra*, *Khair*, *Salai*, *Babul*, *Palash*, *Kullu*. It was also observed that gum collectors of different villages used a local iron tool and sickle shape tapping tool for tapping salai gum from *Boswellia serratta* tree and collects after 20-25 days from the date of tapping. On an average, 150-250 g salai gum per tree collected by local people. Local peoples also collect gum from trees like *kardhai*, *khair*, *dhawra*, *palash* etc.

**Sub-Project 7:** Development of *guggul* library.

- Centre has developed a *guggul* library of samples since 2015 and constantly analyzed to record the changes in physico-chemical properties. The next plan of work is for identification of bioactive compounds from these samples. This information will of value to both cosmetic and drug industry. This year the centre has filed a patent application on storage method of *guggul*.

## **VNMKV, Parbhani**

**Sub-Project 1:** Effect of processing methods on tannin content of guar korma meal.

- Tannin content of guar korma meal were examined by different processing methods where the autoclaving and extrusion showed higher reduction in tannin content of 0.38g/100g (78.23%) and 0.31g/100g (82.08%) respectively. Lowest reduction was observed in soaked sample 0.93g/100g (46.24%).

**Sub-Project 2:** Development of instant tomato soup powder by fortification of PHGG as a soluble fiber source and its characterization.

- Incorporation of 15% partially hydrolyzed guar gum in instant tomato soup powder improved the flowability, reconstitution properties, solubility, water solubility index and wettability along with increase in soluble dietary fiber. Developed instant tomato soup powder can be safely stored up to 90 days at refrigerated condition in polypropylene packaged pouches.

**Sub-Project 3:** Development of guar seed fractions based edible film.

- Use of guar meal can be replaced by 40% potato starch in the casting solution as well as in edible film. The addition of guar meal and PHGG along with plasticizers had good mechanical, barrier and film forming abilities.
- The effect of prepared casting solution as a coating material for plum fruits revealed that shelf life was also extended up to 14 days as compare to uncoated fruits without affecting their sensory attributes.

**Sub-Project 4:** Effect of feeding different of guar korma meal on growth performance on kaveri chicken.

- Feeding trails of chicken, soy meal can be replaced up to 12% with protein rich guar meal korma in poultry feed ration and found to be acceptable for poultry birds.

## **TNAU, Coimbatore**

**Sub-Project 1:** Network Project on “Harvesting Processing and Value Addition of Natural resins and Gums” - Tamarind Seed Gum.

**Flower and fruiting in florigen applied tamarind germplasm**

- In 5 tamarind germplasm planted, Hasanur 06 sprayed with foliar application of Paclobutrazol 500 ppm showed maximum flowering and fruiting in tamarind and Hasanur 06 and PKM 1 showed maximum fruiting percentage.
- Organoleptic evaluation of value added products from tamarind flower and tender tamarind was studied and concluded that Paclobutrazol 500 ppm was recorded highest in three growth stages and the lowest in (Control) on the basis of value for chlorophyll contents (Chlorophyll ‘a’, chlorophyll ‘b’, total chlorophyll and chlorophyll a/b ratio).

**Documentation of entomofauna infesting *Tamarindus indicus* both under field and storage and potential pollinators of tamarind**

- Total 11 species of insect pests and 3 species of natural enemies were documented both in the tamarind plantation and seed storage and found three species of sucking pests, fruit borers, seed borers/kernel powder feeder among eleven species of insect pests and two species of defoliators documented in tamarind plantation. Natural enemies include two species of spiders and preying mantids. It was observed that potential pollinators of Tamarind viz., *Apis florea*, *Apis dorsata*, *Apis cerana*, *Amegilla zonata*, *Trigona spp*, *Xylocopa sp.*, *Camponotus sp.*, *Sarcophaga sp.*, *Certina hieroglyphica* were visited during the peak period of flowering.

### **Preliminary studies on assessing gum production in few tree species of regional importance**

- Gum booster dosage of 400 mg/ml of ethephon concentration and 1.2% H<sub>2</sub>SO<sub>4</sub> concentration was found to be significantly superior over other treatments in *Chloroxylon swietenia*, *Pterocarpus marsupium* and *Butea monosperma* and diameter class of 60-90 cm was found to be superior over other diameter class in terms of gum production.

### **Gum tapping experiment on *Moringa oleifera***

- In *Moringa oleifera*, maximum gum yield 42.80 g was observed (Hand drilling with 4 ml gum inducer) and minimum (Mechanical drilling without gum inducer) in diameter class of 90-120 cm under non-irrigated condition. Under irrigated condition, maximum yield (102.20 g) was observed followed by (84.60, 63.20 and 57.10) whereas minimum with gum yield of 17.90 g in diameter class of 90-120 cm. Within the span of 3 months' observation, diameter class of 90-120 cm produced more gum yield than diameter class of 30-60 cm and 60-90 cm.

### **Augmenting existing tamarind germplasm**

- During April 2020 – March 2021, 4 new tamarind germplasm namely Urigam 112, Red tamarind 1, Red tamarind 2, Red tamarind 3, Red tamarind 4, Vellore 28, Vellore 66, Vellore 1, Kumbam were collected and planted in tamarind gum garden. The biometric measurement for the existing tamarind germplasm (Hasanur 06, Hasanur 09, PKM 01, Javathu Hills, Mullampadi, Urigam, Jamnamathur, Amirthi 1, Amirthi 2, Pernampet and Sweet tamarind) were recorded and correlated with the flowering and fruiting characters.

### **Assemblage of gum yielding tree species of regional importance**

- *Acrocarpus fraxinifolius*, *Vachellia nilotica* and *Pterocarpus marsupium* were found superior in biometric observation (Height and girth at breast height). The tree species planted during the current year (December, 2020 – September, 2021) were *Pterocarpus marsupium*, *Butea monosperma*, *Prosopis cineraria*, *Acacia ferrugenia* and *Acacia leucophloea*, *Moringa oleifera*, *Lannea coromendalica* and *Pterocarpus santalinus*.

## **Dr. YSPUHF, Nauni, Solan**

### **Sub-Project 1: Effect of Anatomical Characteristics on oleoresin yield.**

- Anatomical characteristics in *Pinus roxburghii* Sargent was determined. Maximum number of resin ducts 1.17/mm<sup>2</sup> was observed in diameter class D<sub>4</sub> (>60 cm) and minimum 0.86/mm<sup>2</sup> was noticed in diameter class D<sub>1</sub> (30-40 cm).
- Maximum tracheid length (4.12 mm) and tracheid diameter (0.077 mm) was observed in diameter class D<sub>4</sub> (>60 cm) whereas, minimum tracheid length (3.09 mm) and tracheid diameter (0.51 mm) was noticed in diameter class D<sub>1</sub> (30-40 cm) and D<sub>2</sub> (40-50 cm), respectively.
- Maximum ray height (0.45 mm) was observed in diameter class D<sub>3</sub> (40-50 cm) and minimum (0.025 mm) was noticed in diameter class D<sub>1</sub> (30-40 cm). Maximum (0.050 mm) and minimum ray width (0.023 mm) was noticed in diameter class D<sub>4</sub> (> 60 cm) and D<sub>1</sub> (30-40 cm), respectively. Maximum Frequency/number of medullary rays (37.10/mm<sup>2</sup>) was found in diameter class D<sub>4</sub> (>60 cm) and minimum (27.93/mm<sup>2</sup>) was recorded in diameter class D<sub>1</sub> (30-40 cm).

### **Sub-Project 2: To study the anatomical characteristics of wood of *Pinus roxburghii* from different progenies.**

- To determine anatomical characteristics *Chir Pine* trees were marked and wood samples at breast heights were collected. Maximum ray length (0.439 mm) was recorded in progeny Kaldoo P4 and minimum (0.188 mm) was noticed in Dibkon P3 progeny. Maximum (0.045 mm) and minimum ray width (0.018) was observed in Kaldoo P4 and Leda P5 progenies, respectively. Maximum (37.10/mm<sup>2</sup>) and minimum number of rays (27.04/mm<sup>2</sup>) was found in



Kopra P5 and Kaldoo P9, respectively. Maximum tracheid diameter (0.085 mm) was observed in Kopra P5 and the minimum (0.049 mm) was noticed in progenies Rakni P8 and Kather PT Black Centre.

### **Sub-Project 3: Demonstration of Borehole Technology of oleoresin tapping.**

- Borehole method of oleoresin tapping was demonstrated to 40 Range Forest Officer trainees of State Forest Department of Himachal Pradesh on September 28<sup>th</sup>, 2021.

## **KAU, Thrissur**

### **Sub-Project 1: Harvesting, processing and value addition of natural dammars of Kerala.**

#### **Preparation and standardisation of black dammar dhoop cones**

- Size and shape of the dhoop cones were standardized before developing it as a commercial product based on the market trends, fume production and ease of making. Height and diameter of dhoop cones were selected as 2.5 cm and 1.2 cm, 2.5 cm and 1.8 cm, 3.5 cm and 1.5 cm and 3.5 cm and 1.8 cm for different size of dhoop cones. Selected cone sizes were made using different compositions of pre-mix powder and black dammar for studying the burning duration which consist pre-mix powder and black dammar powder at 1:1 ratio, 1:0.75 ratio and 1: 0.50 ratios. Dhoop cones were prepared using both paper and mild steel moulds. The burning duration of dhoop cones were estimated by burning the cones placed on cardboard in well-ventilated room.

#### **Dhoop cone preparation**

- In order to prepare dhoop cones, finely powdered black dammar was mixed with pre-mix powder and required amount of water added and thoroughly mixed by hand and made in paste form. Vegetable oil (coconut oil or gingelly oil) was added to this paste and mixing was repeated. Two types of moulds were used to prepare dhoop cones. Dhoop cones of four dimensions (height -2.5 cm and diameter 1.2 cm, height -2.5 cm and diameter 1.8 cm, height - 3.5 cm and diameter 1.5 cm, height -3.5 cm and diameter 1.8 cm) were selected using paper mould.

#### **Pedal operated incense stick making machine**

- Pedal operated incense stick making machine is an ideal machine for commercial production of incense sticks which consists foot pedal, pawl and ratchet mechanism, piston cylinder arrangement, chain drive, rack and pinion system and an extruder. The machine is ergonomically designed to transmit the force applied on the foot pedal to the piston of the cylinder which contains agarbatti paste. The compressive force then causes the extrusion of the incense stick. Fabricated machine can manufacture 20 to 30 incense sticks per minute and cost of the machine is approximately Rs. 7000-8000 which is much lesser than the machine commercially available in market (Rs. 15,000-50,000).

#### **Collaboration with Kerala State Federation of SC ST Development Co-Operatives Ltd**

- KSFSCSTDC Ltd., Trivandrum proposed a technical alliance with College of Forestry for the value addition of dammar and other forest sourced NTFPs. This federation is one of best marketing channels for the NTFPs in the state. Currently they have large number of natural raw resources that they had been selling in the market and they had also requested for the value addition of these resources which is under consideration.

#### **Commercial production & training on black dammar dhoop cones**

- As part of value addition of black dammar, size and composition of the dhoop cones were standardised and commercial production has been started at the production centre attached to College of Forestry. Price of the product will be fixed soon for the sales in the market. Training programmes have also been provided for production of dhoop cones using moulds.

### **Up-gradation of agarbatti making unit into a Production and Training Centre**

- Agarbatti making unit attached to College of Forestry was renovated and upgraded into a Production and Training centre with the objective of conducting training programmes on manual and mechanical ways of agarbatti making.

### **Screening of black dammar incense production on Krishi Darshan programme in DD Malayalam channel and an article published on Mathrubhumi news paper**

- Krishi darshan programme in DD Malayalam channel telecasted an episode on production and marketing of black dammar on 12/11/2020. An article on “Livelihood opportunities for tribals by the production of black dammar agarbatti incense sticks” was also published in the local Mathrubhumi newspaper on 18/09/2020.

### **Sub-Project 2: Standardization of nursery techniques of *Canarium strictum* (Black dammar) and *Vateria indica* (White dammar) and their mass multiplication through tree nursery**

- Ripe fruits of white dammar (*Vateria indica*) were collected from standing trees during the month of July. The three valved, 1 seeded fruits are pale brown in colour and the seeds inside show viviparous nature. The ripened and unopened fruits were selected for the study. The fruits, which are ovoid to ellipsoid in shape, are of the average size. About 40 to 42 fruits of normal size weigh one kilogram.

### **Germination percentage**

- Germination percentage is the parameter to determine the percentage of seeds being germinated from the total sown fruits. Seed germination was highly effective in the treatments, whereas lowest germination percentage was recorded in (Hot water treatment for 5 Minutes) with 20% of seed germination.

### **Extension activities under network project**

- College of Forestry conducted several outreach programmes on sustainable harvesting and value addition of black dammar including making of black dammar incense sticks at different tribal settlements in Kerala. Training was imparted to tribals in scientific harvesting of dammars and agarbatti making.
- Network centre started an Agarbatti making unit in the main campus, wherein tribals were brought from different settlements and trained in manual and mechanical production of incense sticks. Now, agarbatti making unit in the centre has been elevated as an *Agarbatti Production and Training centre*. Besides these training programmes, black dammar incense sticks were produced in this unit and sold through various outlets of KAU. Now more than a thousand black dammar incense sticks packets were sold through these outlets, and as a mosquito repellent, it has become more popular among the public. Additionally, black dammar dhoop cones were also developed as a product and training in dhoop making were also provided.

## **ICAR-CAFRI, Jhansi**

### **Sub-Project 1: Growth and Productivity of Agro forestry models.**

#### **A.1. Agroforestry models on-farm**

- During summer season 2020, natural exudation of gum in different fields of *A. senegal* was observed. Gum yield ranged from 11.34–133.24 g/tree in agri-horti-silviculture model (average: 61.76 g from 6 trees), 1.51–110.0 g/tree in rainfed agri-silviculture model (average: 33.15 g from 21 trees), 0.73–104.43 g/tree in old gum garden (average: 22.21 g/tree from 13 trees), 1.92–177.39 g/tree in new gum garden (average: 33.52 g/tree from 11 trees) and 25.82–44.25 g/tree (average: 25.00 g/tree from 7 trees) in block plantation in rocky area.

- Natural exudation of gum in different fields of *A. nilotica* was also observed and gum yield ranged from 8.25–26.59 g/tree in silvi-herbal model (average: 17.57 g/tree from 5 trees) and 0.43–83.23 g/tree in rainfed agri-silviculture (average: 14.78 g/tree from 10 trees).

### **Gum garden**

- Survival and annual growth data of *A. senegal* based gum gardens were observed and found higher survival % in *A. senegal* than *B. monosperma* in both the gardens. *A. senegal*, planted in new gum garden *i.e.* during 2015, attained good girth and showing relatively higher survival (%) than that planted during 2014. Out of 190 plants of *A. senegal* in old gum garden, 31 yielded *gum-arabic*. Out of 268 *A. senegal* trees in new gum garden, natural exudation of *gum-arabic* was observed from 23 trees.

### **A2. Agroforestry models on farmers' fields**

- After 11 years of planting, *A. senegal* recorded relatively more survival (up to 59.5%) than *A. nilotica* (up to 50%) at Garhkundar watershed area. At village Ambabai, 37% survival of *A. senegal* with average height of 294.5 cm and average collar diameter of 17.5 cm was recorded.

## **B. Demonstration and Development of Gum-Yielding Tree-based Agroforestry Models**

### **B1. At institute research farm**

- During rainy season 2020, 4 different bio-fence models were practiced for observation of plant growth and their survival rate using single and double row method where maximum survival percentage was noticed in model-3 in *Acacia senegal*.

### **B2. At farmer's fields**

- During rainy season 2020, approximately 35000 quality seedlings of *A. senegal* were raised in nursery at ICAR-CAFRI, Jhansi out of which, 30000 seedlings were provided to enable "Doubling Farmer's Income (DFI)" for planting in seven districts of Uttar Pradesh. At each site, 4-5 farmers have been identified for developing horti-silviculture, agri-horticulture and agri-horti-silviculture models. *A. senegal* has also been planted on field boundaries as it acts as bio-fence.

## **C. Gum Exudation in Relation to Soil Moisture Dynamics**

- Study was carried out on various gum-yielding tree based agroforestry models to assess relation between natural exudation of gums from *A. senegal* and *A. nilotica* with soil moisture content (%). Soil samples were collected from two different depth (0-15 and 15-30 cm) of *A. senegal* and *A. nilotica* (within 0.5 m distance from tree trunk) growing in agri-horti-silviculture model, silvi-herbal model, rainfed agri-silviculture model and gum gardens (new and old) at 15 days interval. Moisture content (%) was determined by gravimetric method.

## **D. Soil Health of Agroforestry Models**

### **Agri-horti-silviculture model:**

- Study on effect of woody perennials on soil properties was carried out in the plant species of agri-horti-silviculture model. Study consisted three factors *viz.*, plant species (*A. senegal*, *A. marmelos*, *C. limon* and *C. carandas*), distance from these plant species (0.5, 1.0, 2.0 and 4.0 m) and soil depth (0-15 and 15-30 cm). Different soil parameters *viz.*, pH, electrical conductivity, organic carbon, major nutrients (available N, P and K) and micro-nutrients (Fe, Mn, Zn and Cu) were assessed. Soil pH was recorded maximum in *C. limon* and minimum in *C. carandas*, maximum EC and organic carbon were recorded in *A. Senegal*. Highest soil pH, EC and organic carbon were recorded in the samples collected from near tree base of 0.5 m and 0-15 cm soil depth. Available N and Mn was recorded maximum in *A. Senegal*, P in *C. limon* and K in *C. carandas*. Higher available N, P and K were recorded from surface soil of 0-15 cm. Available Zn in *A. marmelos* which was at par with *C. carandas*; and available Cu in *C. limon* and it was found at par with *A. marmelos*. In all studied plant species, values of all

the micro-nutrients were recorded maximum at 0.5 cm distance and minimum at 4.0 m distance.

### **Rainfed agri-silviculture model:**

- Study on effect of gum-yielding plant species on soil properties was carried out in rainfed agri-silviculture model. Study consisted of three factors viz., plant species (*A. senegal* and *A. nilotica*), planting spacing (5×5, 10×5 and 10×10 m) and soil depth (0-15 and 15-30 cm). Soil pH and EC were recorded maximum in *A. senegal* planted in 5×5 m spacing. Available N and P were recorded maximum in *A. senegal* of 5×5 m spacing. Value of Fe and Mn contents were significantly higher in *A. senegal* planted at 5×5 m spacing. In overall, 0-15 cm soil depth was found superior.

### **ICAR-IINRG, Ranchi**

**Sub-Project 1:** Preparation and characterization of modified guar gum nanocomposite films reinforced with *piyar*-AgNPs for diversified applications.

- Number of nanocomposite films reinforced with *piyar*-AgNPs were developed for diversified applications through solution casting method, by varying reactants i.e. modified *guar* gum (MGG), plasticizer, *piyar*-AgNPs etc., to study the effect on physical, mechanical, thermal, barrier and antimicrobial properties of the resulting nanocomposite (NC) films. Developed nanocomposite films were characterized by physical properties (thickness, opacity, color value), UV-Vis, FT-IR spectroscopy, Field Emission-Scanning Electron Microscopy (FE-SEM) and Energy dispersive spectrum (EDS) analysis and Differential Scanning Calorimetry (DSC). Developed nanocomposite films were also characterized by mechanical properties (tensile strength, flexibility). The antifungal evaluations of developed nanocomposite films were carried against *Aspergillus niger*.

### **Color value (L, a and b value) of nanocomposite films**

- Color values (L, a & b) of the developed nanocomposite films were determined using Hunter colorimeter. L - values increased with increasing concentration of the nanoparticles in the films resulted darker color of the films. Further, the films showed negative 'a' values for greenish and positive 'b' values for yellowish color.

### **FE-SEM and EDS analysis of the nanocomposite film**

- Field emission-scanning electron microscope images of the developed nanocomposite films were recorded to obtain the morphological features of the films and observed flat, dense, and homogeneous. On the other hand, SEM images of films are characterized by uniformly distributed silver nanoparticles (AgNPs) which are identified as white spots on the smooth surfaces of the nanocomposite films. The FE-SEM images of the cross section of films indicated incorporation of AgNPs. SEM image of films cross section also showed formed nanoparticles and indicated uniform distributed throughout the film thickness.
- Absorption peak at 20 keV in the EDS spectrum of nanocomposite film confirms the presence of elemental Ag and results demonstrate that 0.07% nanoparticles formed inside the film.

### **DSC thermogram of the nanocomposite film**

- DSC thermogram of nanocomposite films was carried out to determine thermostability of developed films. DSC thermogram of the nanocomposite films were shown one endothermic peak at 85.44<sup>0</sup>C and one exothermic peak at 287.20<sup>0</sup>C. Endothermic peak indicates loss of water and plasticizer molecules from films whereas exothermic peak indicated thermal degradation of modified guar gum and plasticizer molecules in the films. DSC thermogram also indicated that onset of thermal degradation started at 260<sup>0</sup>C. Results indicated that developed nanocomposite films are thermostable upto 250<sup>0</sup>C.

### **Mechanical properties of the nanocomposite film**

- Mechanical properties of films are found significant as this property directly impacts other properties of the film. Mechanical strength of polymer films depends on their chemical structure and packaging films must have good mechanical strength to withstand the external stress during processing, transportation and usage. Thus, for improved mechanical strength of modified guar gum silver nanoparticles impregnated nanocomposite films were developed and mechanical properties such as tensile strength, modulus and elongation at break values or break strain of control evaluated for nanocomposite films. Study reveals that nanocomposite film has improved mechanical strength *i.e.* tensile strength and modulus than control film. This enhancement of tensile strength and modulus indicates the excellent interaction between polymer matrix and Ag nanoparticles, and intermolecular forces and electrostatic force between Ag nanoparticles and polymer matrix that makes the film strengthened and shows better mechanical properties. Similarly, the break strain or percentage of elongation is more for nanocomposite films. This may be attributed to the fact that Ag metal nanoparticles make the film more flexible. It was noticed that incorporation of Ag nanoparticles increases tensile strength and make the film more flexible.

### **Antifungal evaluation of nanocomposite film**

- Antifungal susceptibility test of the developed nanocomposite film was done by agar-well diffusion method. Fungal strain of *Aspergillus niger* was first grown in potato dextrose liquid medium broth and incubated at 30°C for 5 days before use. Conical flask containing potato dextrose agar solution was cotton plugged and autoclaved at 15 psi pressure and 121°C temperature for 15 min. The plate was sterilized and then seeded with prepared sample of pathogen with the help of a sterile stainless spreader. Four agar wells of 6 mm diameter were labelled as 1, 2, 3 and C (control). The wells 1, 2 and 3 were loaded with 1 cm<sup>2</sup> section of nano-composite films and the well C was loaded with 100 microliter of Ag solution. The plates were incubated at 37°C for 96 h and the zone of inhibition (ZOI; mm) that appeared around the wells was recorded. The results showed that nanocomposite film showed promising antifungal activity as compared to control.

### **Sub-Project 2: Exploration of minor gum and resin plants in India and preparation of field guide.**

- During the year 2020-21, visits were made to surrounding forest areas of Ranchi, Jharkhand and photographs were taken for missing plant parts of some gum-resin trees. During local surveys photographs of season specific plant parts including flowers, fruits, leaves, whole plants and gum exudation of different plant species were taken. Various plant parts of the trees like *Garuga pinnata*, *Spondias mombin*, *Acacia sieberiana*, *Acacia polyacantha*, *Albizia amara*, *Albizia lucidior*, *Bombax ceiba*, *Delonix regia*, *Samanea saman*, *Leucaena leucocephala*, etc. were photographed and the seasons were noted.
- In order to increase scope of the study, two centres namely KAU, Thrissur, Kerala for photographing different plant parts of gum and resin plants of western ghats of Kerala and CAZRI, Jodhpur, Rajasthan for arranging photographs of different plants parts of the gum-resin producing trees from the arid regions of Rajasthan were involved in the project.

### **Sub-Project 3: Effect of tapping techniques on gum yield from *Moringa oleifera* trees.**

#### **Improvement in fabricated gum tapping die/tool**

- Gum tapping die/tool fabricated based on detailed manufacturing design drawing developed in Pro Engineer CAD Software in collaboration with ICAR – CIAE, Bhopal and further modified for smooth functioning of the developed gum tapping die/tool based on field evaluation trials of *moringa* gum tapping from *Moringa oleifera* trees at Kankebar, Ramgarh district in Jharkhand.
- After field evaluation trials of modified gum tapping die/tool in actual field condition for *moringa* gum tapping from *Moringa oleifera* trees, modified model of gum tapping die/tool

further improved to standardize the gum tapping die/tool for gum tapping from selected tree species and stopper mechanism was included in the standardized model, so that depth of blaze/incision on the tree trunk may be maintained as per requirement.

**Experimentation on *moringa* gum tapping from *Moringa oleifera* trees**

- Suitable trees of *Moringa oleifera* selected at Kankebar, Ramgarh (Jharkhand) to conduct *moringa* gum tapping experiment from *Moringa oleifera* trees under the project and work initiated in the last week of July 2020 with different treatment and completed in July, 2021.

**Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums  
ICAR- IINRG, Ranchi- 834010**

List of centre-wise Research Activity for the year 2020-21

	ICAR Institutions			SAU's						Total
	IINRG, Ranchi	CAZRI, Jodhpur	CAFRI, Jhansi	Dr. YSPUH&F, Solani	VNMKV, Parbhani	IGKV, Raipur	JNKVV, Jabalpur	TNAU, Coimbatore	KAU, Thrissur	
<b>Research Paper published with NAAS Rating (NAAS Rating)</b>	01 (6.42)	01 (3.98)	03 (7.97, 5.10, 5.19)	-	01 (5.23)	01 (4.13)	02 (5.38, 9.56)	01 (3.07)	-	<b>10</b>
<b>Research Paper Presented</b>	04	03	-	03	05	-	-	02	02	<b>19</b>
<b>Technologies Developed</b>	-	-	02	-	02	-	-	-	01	<b>05</b>
<b>Technologies licensed</b>	-	-	-	-	-	-	02	-	-	<b>02</b>
<b>Patent filed</b>	-	-	-	-	-	-	01	-	-	<b>01</b>
<b>Books published</b>	01	-	-	-	01	-	-	-	-	<b>02</b>

**ATR on Recommendations  
of  
12<sup>th</sup> Annual workshop of AINP on HPVA of NRG  
held at  
ICAR – Indian Institute of Natural Resins & Gums  
Namkum, Ranchi (Jharkhand)  
(December 22-23, 2020)**



**ICAR-Indian Institute of Natural Resins and Gums  
(Indian Council of Agricultural Research)  
Namkum, Ranchi – 834 010  
Jharkhand, India**



**ATR on Proceeding of 12<sup>th</sup> Annual workshop of All India Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums held at ICAR – Indian Institute of Natural Resins and Gums, Ranchi (Jharkhand), during December 22-23, 2020.**

**ATR of ICAR-CAZRI, Jodhpur**

Sl. No.	Recommendations	ATR
1.	Centre should coordinate with JNKVV, Jabalpur, and TNAU, Tamil Nadu, respectively regarding guggul and moringa gum tapping research work.	The PIs of JNKVV, Jabalpur, and TNAU, Tamil Nadu contacted and research work on guggul and moringa gum tapping is being done with their consultation.
2.	A study on the difference in quality parameters of gum produced from <i>Acacia senegal</i> and <i>Acacia nilotica</i> should be included in the project.	Physio-chemical study for both <i>Acacia senegal</i> and <i>Acacia nilotica</i> gum included in the Sub-project.
3.	Plan of action for commercialization of technologies/products developed should be prepared and best technologies/products developed by the centre be promoted.	The standardization of best processing technology is in progress and best processing technology on identification is planned to be commercialized accordingly.
4.	Details of products/technology commercialized/transferred by the centre should be submitted to coordinating centre for onward transmission to council including social and economic impact of the project.	On commercialization of products/technology, report will be submitted.
5.	Study on qualitative difference in gum production with and without gum inducer should be studied including effect on tree physiology i.e., canopy, health etc.	The earlier studies from CAZRI reported the qualitative difference in gum production with and without gum inducer. However, the study will be done again including effect on tree physiology.
6.	Effect of input on gum production and tree physiology may be included for study under the project.	The study suggested included in the Sub-project.

**ATR of IGKV, Raipur**

Sl. No.	Recommendations	ATR
1.	Extruded products developed by the centre should be promoted in collaboration with government departments / industries	The proposal for the promotion of the product is under consideration at University and the State Government level.

**ATR of JNKVV, Jabalpur**

Sl. No.	Recommendations	ATR
1.	Proposal for commercialization of Jawahar Guggul Laddu may be submitted to the council through coordinating centre.	A detailed proposal for Guggul laddu making machine worth Rs. 10 lakhs is already submitted to the Project Coordinator unit
2.	Guggul drupe collector device developed by the centre should be promoted in the region	The device is promoted among guggul drupe collectors. This year's pandemic restrictions with hold our distribution plan
3.	Planting material of guggul (seed/plant) may be provided as per the requirement of coordinating centre, ICAR – IINRG, Ranchi	Fresh guggul seeds sent to both the coordinating Centres

	and TNAU, Tamil Nadu at the earliest for the regeneration of guggul plantation at their respective plantation.	
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### ATR of VNMKV, Parbhani

Sl. No.	Recommendations	ATR
1.	Centre should focus on the commercialization of the developed technologies / products.	<ul style="list-style-type: none"> <li>Center has released developed technologies in Joint Agricultural Research and Development Committee in SAU's of Maharashtra at State Level and also commercialized developed technologies/products to the Food product manufacturers.</li> <li>Center has transferred technology and given consultancy regarding the use of guar gum in food products for its commercialization to following industries.               <ol style="list-style-type: none"> <li>Hiranya Food Products Pvt Ltd, Sanpuri, Dist-Parbhani</li> <li>Botanika INDIA, Kalyan Nagar, Basmat Road, Parbhani</li> </ol> </li> </ul>
2.	Study on adverse effects, if any of guar meal-based products/technology developed at the Centre for pets be included under the project.	A study on the adverse effect of guar meal-based products/technology developed at the Centre for pets has been carried out for a reduction in anti-nutritional factors in guar meals to decide its safety in food products.
3.	Technology/products developed for pets may be commercialized.	Technology/products developed for pets are under process of commercialization with negotiations of pet feed industries and pet food sellers at domestic and regional levels.
4.	Centre should focus on the extraction of important constituents from guar and by-product of guar gum industries instead of the development of guar-based bakery, dairy, and other products.	Center has already taken over the extraction of important constituents from guar especially their derivatives and the by-product of guar industries and the basic work has been undertaken to get rid of anti-nutritional factors in guar korma meal for use it as cattle feed instead of the development of guar-based bakery, dairy, and other products and also explore the utilization of guar meal and PHGG for preparation of the edible film.
5.	Centre should work in close association with Department of Agricultural Process Engineering of College of Agricultural Engineering & Technology, Parbhani	Centre is in close association with Dr. S. N. Solanki, in Incharge, AICRP on UAE, College of Agricultural Engineering & Technology, VNMKV, Parbhani working on mechanization and value addition for development/Refinement package practices of guar for cultivation (Sowing / Harvesting) and small machine for guar products and its value addition.

### ATR of TNAU, Coimbatore

Sl. No.	Recommendations	ATR
1.	Centre should assemble all the processing machinery related to tamarind gum at one place	A separate "Tamarind processing unit" has been established at the Forest College and Research Institute, Mettupalayam campus by assembling tamarind processing machinery namely de-huller, seed roaster, decorticator, tray dryer, and pulverizer.
2.	Centre PI may visit ICAR – CIAE Regional Centre,	Visited the ICAR- CIAE centre, Coimbatore on 5-2-2020 and studied the machinery related to Tamarind

	Coimbatore, and see machines developed for tamarind processing for their possible use in making tamarind seed gum and establishing a pilot plant.	processing. Now Closely associate with Dr.P. Balasubramanian, Principal Scientist and Head, ICAR-CIAE centre, Coimbatore, and the machinery and equipment available in the centre is also used for research and training purpose for the project.
3.	Moringa gum-based technologies/ products may be developed at the centre.	Gum tapping blazer – 75 developed by ICAR- IINRG, Ranchi was received on 17-6-2021. The Moringa gum tapping work is initiated from June 2021 onwards as per the treatment communicated by the network coordinator of HPVA of NRG, IINRG, Ranchi

#### ATR of Dr. YSPUH & F, Solan

Sl. No.	Recommendations	ATR
1.	Study-related to application development and value addition of rosin should be included in the project activity in collaboration with AICRP on Post-Harvest Technology, Solan Centre.	Application development and value addition of rosin included in the current year <i>i.e.</i> 2021-22 programme.
2.	Studies on the development of multiple boreholes to obtain enhanced resin production should be included under the project as in the case of the rill method.	Work on the development of multiple boreholes for enhanced resin productions has been initiated and will also be continued during 2021-22.

#### ATR of KAU, Thrissur

Sl. No.	Recommendations	ATR
1.	The resource base for resin and gum production needs to increase in the region in association with the state government department.	Discussed with the forest department officials to follow silvicultural techniques for enhancing natural regeneration of <i>Canarium strictum</i> and <i>Vateria indica</i> in its natural habitats. Started mass production of seedlings of the above two species in the college tree nursery for raising plantations outside conventional forest areas.
2.	Product/technology of black dammar based Agarbatti/Dhoop may be commercialized through industries already making such products.	Agarbathi incense sticks and Dhoops are being sold through university outlets. We have contacted a few small industrial units and Eco-development committees to adopt this technology for mass production and sale of these products through their outlets.

#### ATR of ICAR-CAFRI, Jhansi

Sl. No.	Recommendations	ATR
1.	Correlation between moisture and gum yield may be included in the study.	During the current year, the effect of soil moisture dynamics on exudation of gum from <i>Acacia senegal</i> in irrigated as well as rainfed conditions were studied. Based on initial data, a correlation matrix was worked out among all parameters of rainfall, soil moisture, and gum exudation. For irrigated conditions, data indicated that a positive but non-significant correlation existed between soil moisture ( $r = 0.236$ ) and mean gum yield (g/tree) and the number of trees exuding gum. Total annual rainfall in the preceding year had a direct

		influence on the number of trees with multiple exudations in a year ( $r = 0.763$ ). Contrary to irrigated conditions, in rainfed models total gum yield exhibited a better positive correlation with soil moisture content ( $r = 0.559$ ). Further, the number of trees exuding gum also increased with soil moisture as evidenced by a significant positive correlation ( $r = 0.676$ ) between the two. A significant positive correlation existed between total gum yield and the number of trees with multiple exudations in a year ( $r = 0.957$ ). Rainfall in the preceding month of the same year had a direct effect on mean gum yield. A significant positive correlation existed between soil moisture content and the number of trees with multiple exudations in a year.
2.	The effect of lac cultivation on gum yield from Palash tree should be analyzed in detail.	The centre has carried out experiments, to study simultaneous production of gum and lac on <i>Butea</i> trees to assess the effect of gum exudation on lac production and <i>vice versa</i> . The study revealed that when simultaneous production of gum and lac are taken on <i>Butea</i> trees, the yield of both gum and lac is reduced in comparison to their sole productions. When lac and gum are taken simultaneously, the yield of lac is reduced to 1.3 kg/tree in comparison to 2.1 kg/tree from sole lac cultivation. Similarly, the yield of gum was also reduced to 75.3 g/tree in comparison to 251 g/tree from sole gum production. The B:C ratio of lac cultivation was 1.82. Survival of lac insects on <i>Butea</i> trees during the summer season is a challenge in the Bundelkhand region of central India. The complete mortality of lac insects has been noticed if the temperature goes beyond 45°C and the relative humidity drops below 12%. <b>For further detailed studies on lac cultivation on <i>Butea</i> and other host trees, a concept note has already been submitted by ICAR-CAFRI for including it as one of the partners in the Network Project on Lac coordinated by ICAR-IINRG, Ranchi.</b>
3.	Products/ technologies <i>i.e.</i> bio-fencing technology, Palash gum tapping tool, and Palash gum-based <i>laddu</i> should be documented in form of book/ booklets/ folder including economic analysis for commercialization through line department and other suitable organizations.	For different technologies, we have published the following bulletins/ leaflets: 1. Prasad, R., Kumar, S., Shridhar, K.B., Singh, R., Shukla, A., Singh, P. and Chaturvedi, O.P. (2017). <b><i>Bundelkhand mein lakh evum gond utpadan: Jeevikoparjan ka aadhar</i></b> . Extension Bulletin-07/2017, ICAR-Central Agroforestry Research Institute, Jhansi (U.P.). 2. Prasad, R., Shukla, A. and Singh, P. (2017). <b><i>Bundelkhand kshetra mein palash per lakh evum gond utpadan ki digdarshika</i></b> . ICAR-Central Agroforestry Research Institute, Jhansi (U.P.). 3. राजेन्द्र प्रसाद, रमेश सिंह, ए.के. हाण्डा, बद्रे आलम, के.बी. श्रीधर, अशोक शुक्ला एवं प्रशान्त सिंह. (2018). <b>बुन्देलखण्ड क्षेत्र में अकेशिया सेनेगल आधारित कृषिवानिकी -उपाय एक लाभ अनेक।</b> तकनीकी बुलेटिन 04/2018, भा.कृ.अनु.प. -केन्द्रीय कृषिवानिकी अनुसन्धान संस्थान, झांसी (उ.प्र.), पृष्ठ : 40. 4. राजेन्द्र प्रसाद, रमेश सिंह, ए.के. हाण्डा, बद्रे आलम, अशोक शुक्ला, प्रशान्त सिंह, आनंद कुमार सिंह, आर.के. तिवारी एवं सुधीर कुमार

		<p>(2019). खेतों की मेड़ पर कुमट (गम अरेबिक) की सजीव बाड़ लगाएँ गौद से आय एवं अन्ना-पशुओं से फसल सुरक्षा पाएँ. प्रसार पत्रक-04/2019. भा.क.अनु.प.-केन्द्रीय कृषिवानिकी अनुसंधान संस्थान, झाँसी - 284003, उत्तर प्रदेश।</p> <p>5. Prasad, R., Handa, A.K., Singh, R., Alam, B., Shukla, A., Singh, P., Tripathi, V.D. and Arunachalam, A. (2021). <b>Economic analysis of gum arabic (<i>Acacia senegal</i> (L.) Willd.) based agroforestry model for smallholder farms.</b> Technical Bulletin CAFRI/2021/01, ICAR-Central Agroforestry Research Institute, Jhansi 284003, Uttar Pradesh, India; p. 1-34.</p> <p><b>On gum tapping tools, recipe for making laddu using kamarkas and other products/ technologies, our centre will compile information and prepare documents in the form of books/ bulletins in the coming years.</b></p>
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### ATR of ICAR-IINRG, Ranchi

Sl. No.	Recommendations	ATR
1.	Study on WVTR and OTR should be carried out before recommending any film for packaging	The WVTR and OTR test of the developed nanocomposite films were carried through outsourcing.
2.	Work on preparation of field guide for minor gum and resin producing plants in India may be expedited and published at earliest	Compilation of information about 31 minor gum and resin plants is done. Due to prolonged lockdown and travelling restrictions during COVID-19 pandemic, survey to different states for photographing remaining plant parts and exploring new plants has been delayed. The effort is now being made to complete the remaining work and publish the guide at earliest.
3.	Tapping die developed for <i>Moringa oleifera</i> gum tapping may be sent to Network Project Centre at TNAU for trial and evaluation	Two sets of IINRG - Gum Tapping Blazer - 75 developed under the project sent to Network Project Centre, TNAU, Mettupalayam on May 27, 2021 alongwith metallic hammer for experimentation on <i>moringa</i> gum tapping from <i>Moringa oleifera</i> trees in Tamil Nadu region.