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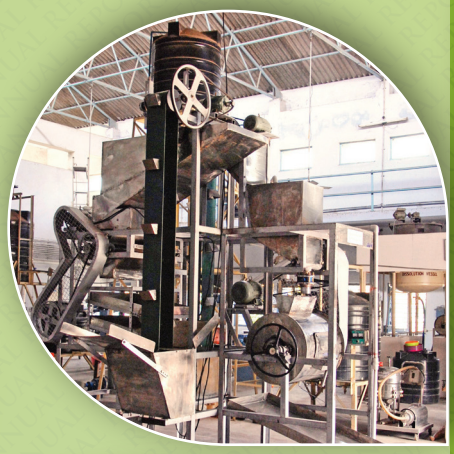

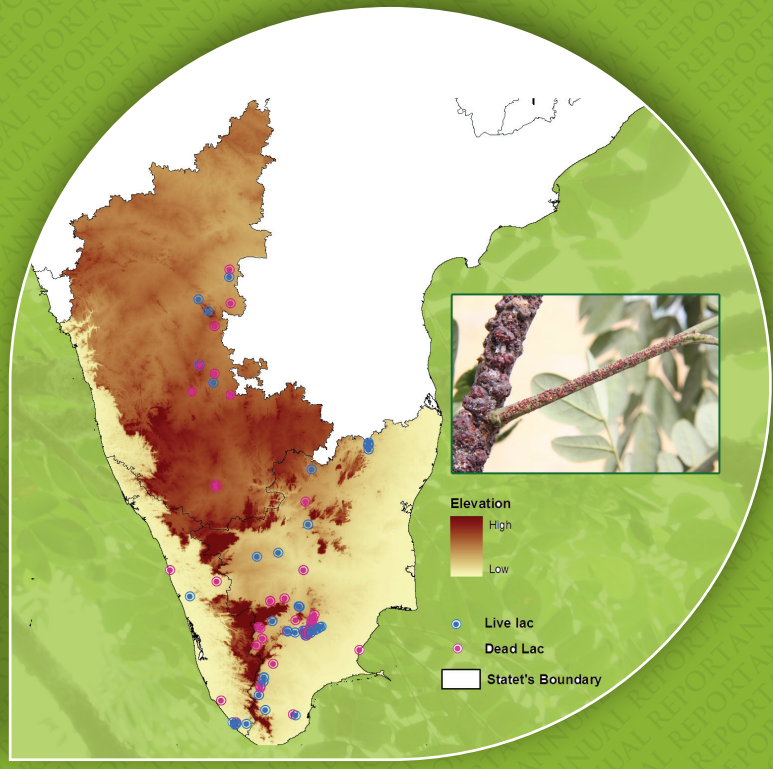

ANNUAL REPORT
वार्षिक प्रतिवेदन

2016-17

ICAR-Indian Institute of Natural Resins and Gums
भाकृअनुप-भारतीय प्राकृतिक राल एवं गोंद संस्थान
Namkum, Ranchi - 834 010 (Jharkhand)
नामकुम, राँची - 834 010 (झारखण्ड)

भा.प्रा.रा.गो.सं. IINRG

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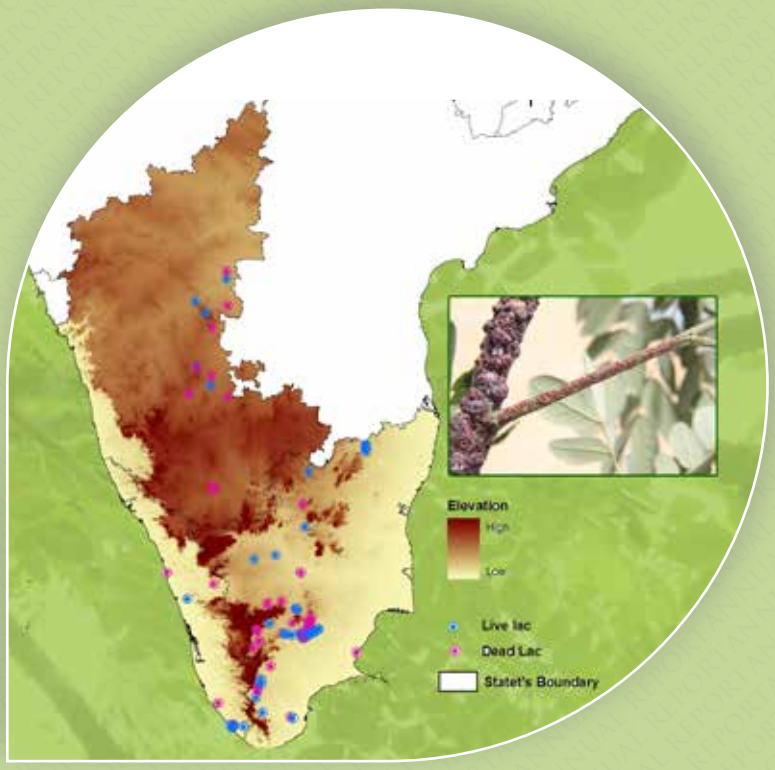

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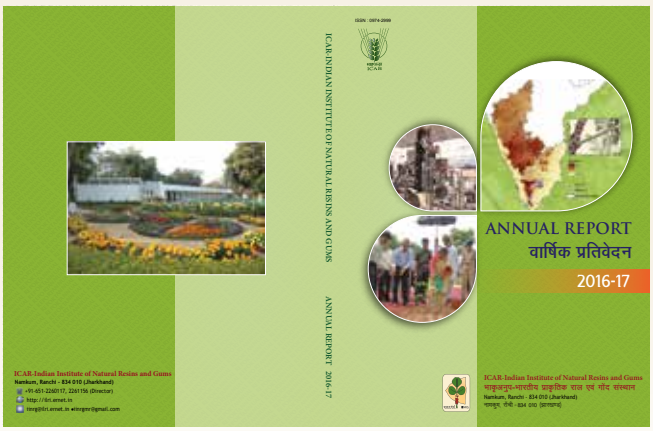

Front Page (Top to bottom)

Elevation range of lac and its distribution in Kerala, Tamil Nadu and Karnataka

Integrated Small Scale Lac Processing Unit

Planting of *Kusum* sapling at IRF by Hon'ble Governor, Jharkhand

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ICAR-IINRG, Director's Office

Contents

Preface

More than 26% of lac insect biodiversity of the world has been reported from India. Some of these lac insects exclusively found in India produce superior quality lac and / or different by-products like dye and wax. This genetic diversity is lying scattered and unattended mostly in the forests. Therefore, collection and conservation of lac insects and host plants is an important activity of the Institute. Three new variants of *palas* (*Butea monosperma*) having yellow flower colour have been identified. Eight districts of Tripura have been surveyed for collecton of lac insects and host plants.

Majority of the farmers in our country hold less than two hectares of land and practice subsistence farming and uncertain mono-cropping. In such situations, integrated farming provides recourse to sustainable and optimum use of resources leading to bio-diversification besides meeting the food and livelihood security. Integration of lac cultivation especially with horticultural crops has promised to be a very promising venture. Lac Integrated Farming System (LIFS) Models developed by the Institute are being evaluated and demonstrated at farmers' fields and has motivated farmers to integrate lac with agriculture.

Lac insects have been found to be very specific in manifestation of their biological attributes not only to the host species, specific varieties and even to individual phenotype of host-plants but also to locality and season of cultivation. Developing package of practices for *kusmi* lac cultivation on *swadi palas* (a variant of *B. monosperma* used for *rangeeni* strain) and utilizing pigeon pea for *rangeeni* lac cultivation has given promising results. A new generation insecticide Augusta™ (active ingredient natural lactose 0.6% and natural alkaloid 0.3%) evaluated on lepidopteron pest *E. amabilis* and *P. pulverea* through dipping of broodlac has indicated its safety to lac insect. Significant reduction in the population of lepidopteron pests was also recorded.

Development of specific molecular markers and establishment of biochemical pathway of lac resin synthesis are important in understanding of genes and proteins involved. The expression profile study of the partial gene of decaprenyl diphosphate synthase, one of the key genes involved in sesquiterpene synthesis cloned from the Indian lac insect, *Kerria lacca* (Kerr) has revealed that this gene expression got up regulated in settled larvae and adult female lac insects in comparison to crawlers. One Suppression Subtraction Library (SSH) library was constructed to identify the differential gene expression in female lac insects compared to crawlers.

Now-a-days, nanotechnologies are being used for developing delivery systems for bioactive compounds. Lyophilized *acacia* gum-based silver nanoparticles (AgNPs) were characterized by UV-VIS, FT-IR Spectroscopy, Particle Size Analysis, Zeta Potential, Atomic Force Microscopy (AFM) and SEM. Use of hydrogel for application in agriculture is another developing field with huge potentials. Cross-linked *guar* gum hydrogels have been synthesized and their dye removal efficiency studied. Different modified derivatives of gum *karaya*, gum *arabic* and gum *ghatti* and *moringa* & *guar* gum based hydrogel polymers have been synthesized as an adsorbent for the removal of heavy metals from water.

Efforts towards value addition of natural resins and gums have led to synthesis of anionic (carboxymethyl), non-ionic (Hydroxypropyl) and cationic (Hydroxypropyl triammonium chloride) derivatives of *guar* gum involving minimum use of organic solvent. Coating formulations based on shellac modified in aqueous and non-aqueous solvent system developed for paper packaging have been found to be smooth, uniform and glossy.

All these research efforts would be futile if not taken to the stakeholders for which they are meant. Commendable efforts have been made in transfer of research findings through training, field demonstrations, technical advisory and extension activities.

Slowly but steadily, the Institute is moving towards achieving the self set tough targets for betterment of both the society and the natural resins and gums sector.

May, 2017
Namkum, Ranchi

(KK Sharma)
Director

Introduction

Mandate

- Research on lac production technologies and processing and value addition of natural resins (including lac), gums and gum-resins.
- Information dissemination, training and technology transfer to farmers, processors and entrepreneurs and tribal people on lac, gums and gum-resins for sustainable livelihood.

Historical Perspectives

India is one of the largest producers of natural resins, gums and gum-resins (NRGs) along with China, Indonesia, Russia and Brazil. Our country is the world leader in production of *guar*, *karaya* and *psyllium* gums as well as lac. Total production of NRG has been increased from 1160314 tons in 2013-14 to 1196308 tons in 2014-15, thus an increase of about 3.1% over the previous year. *Guar* holds the largest share of NRGs produced in India. NRGs are an important source of subsidiary income to farmers in around 70 disadvantaged districts, identified by the Planning Commission. With growing interest in safe and natural material for consumption in various areas, the demand is expected to grow steadily in future. But due to high market price, fluctuation particularly for *guar* gum during 2015-16 total production of NRGs decreased from 1120124 tons in 2014-15 to 844646 tons in 2015-16.

ICAR-Indian Institute of Natural Resins and Gums (ICAR-IINRG) fills in the gap of a National R&D Institution to the NRG sector, which is quite important from social, export and ecological angles. The Institute provides holistic support in research to the NRG sector under one roof, from production of lac-processing-value addition-application development and related areas like quality control, capacity building, to strengthen the sector in the country. The origin of the Institute dates back to 1920s during the British era, when the need for establishment of an R&D organization for lac, a natural resin of insect origin, was felt.

Realizing the strategic importance of this commodity, the then Imperial Government of India constituted the Lindsay-Harlow Committee in 1920 to look into all aspects of the country's lac trade and its development. On the suggestions of this committee, lac merchants organized themselves into the Indian Lac Association for Research, under the aegis of which, the foundation stone of the Indian Lac Research Institute (ILRI) was laid on September 20, 1924 at Ranchi. Subsequently, on the recommendations of the Royal Commission on Agriculture, the Indian Lac Cess Committee (ILCC) was constituted, which took over the reins of the ILRI in 1931. As a result of reorganization of agricultural research and education in the country after independence, the ICAR took over the administrative control of the ILRI in April 1966. This Institute is thus, one of the oldest institutions within the ICAR system, having completed more than 91 years of existence. It has contributed immensely towards all-round development of lac maintaining India's leadership in production, installed processing capacity and export of the commodity.

Recognizing the importance of other natural resins and gums, which are cultivated and collected in the Indian sub-continent, and are of tremendous industrial importance in divergent industries and export markets, the ICAR revised the mandate of ILRI and renamed it as IINRG. All natural gums and resins were brought under its scope, under the revised research mandate of the Institute *w.e.f.* September 20, 2007. Subsequently, the ICAR also sanctioned a new Network Project on Conservation of Lac Insect Genetic Resources launched in August, 2014 with eight centres besides the existing Network Project on Harvesting, Processing and Value Addition of NRGs with increased strength. Since November 29, 2009 the Institute is recognized as National Lac Insect Germplasm Centre (NATLIGEC). On May 30, 2015, the Institute was certified as ISO 9001:2008 organization.

Location and Agro-Climate

The Institute is located 9 km south-east of Ranchi city, on the Ranchi-Jamshedpur highway (NH33) at an altitude of 650 m above mean sea level, $23^0 23''$ N latitude and $85^0 23''$ E longitude. The soil of the experimental farm is of lateritic type. The area experienced mild salubrious climate, with rather good rainfall of about 1105 mm, of which about 89 per cent (986 mm) was during the monsoon season.

Organizational Structure

IINRG has responded to the globalization of industries and agricultural enterprises of the country as well as functional reorganization of ICAR. The Institute also has undergone structural changes and the priorities have been redefined. In 1995-1996, the erstwhile Divisions and Sections were abolished and the scientific manpower divided into three divisions, *viz.* Lac Production, Processing and Product Development and Transfer of Technology. The NATLIGEC maintains Lac-Insect and Lac-Host Plant Field Gene Banks. The Institute is headed by Director.

Staff

The Institute has a sanctioned strength of 1 RMP, 47 scientific, 72 technical, 33 administrative and 84 supporting grade staff with a total of 237 sanctioned posts, out of which 30 scientific including RMP, 42 technical, 23 administrative and 50 supporting posts with a total of 145 staff are in position as on December 31, 2016.

Infrastructure

Manned by a team of dedicated scientists from various disciplines including Agricultural Entomology, Plant Sciences, Organic Chemistry, Engineering, Biotechnology etc., the Institute has about 144 staff in scientific, technical, administrative and supporting categories. The Institute has a number of prestigious labs, like Biotechnology, Bio-control Laboratory, Instrumentation Laboratory, Quality Evaluation Laboratory, High Voltage Laboratory etc. The Institute shoulders the responsibility of collection and maintenance of germplasm of lac insect lines as well as lac host trees. National Lac insect Germplasm Center (NATLIGEC) houses1825 cultures of 73 lac insect lines which include collections from different parts of the country, inbred and crossbred lines are being conserved lives on potted plants of *bhalia* (*F. macrophylla*) under protected conditions in the Lac-Insect Field Gene Bank. Similarly, the Lac-Host Plant Field Gene Bank of the Institute has ninety collections of 29 genera and 55 lac-host species comprising trees, medium and bushy types of lac host plants collected from different agro climatic regions of the country.

There are several well-organized and equipped service sections to support research activities of the Institute. The administrative wing comprises Director's Office, Administrative Section, Audit and Accounts Section, Purchase and Central Stores. The sections providing technical support are Library; Prioritization, Monitoring and Evaluation Cell; Institute Research Farm and Maintenance & Workshop unit. The Auxiliary units are Hindi Cell, Security, Medical and Estate Maintenance services.

The Institute Research Farm (IRF) spread over 36 ha, has all conventional land cultivated lac host plants. Presently, it has approx. 1550 host trees of *Schleichera oleosa* (*Kusum*), 2480 trees of *Butea monosperma* (*palas*), 1351 trees of *Ziziphus mauritiana* (*ber*) and 8700 minor host plants. The IRF also maintains a nursery of host plants for meeting the demand from other institutions as well as farmers.

The ICAR-IINRG Library has a holding of more than 35,000 volumes of scientific journals, 2000 rare books, including back volumes of research periodicals in the field of resins and gums including lac and surface coatings. Since the holdings of back volumes of certain journals date back to circa 1868, the library is also a partner of the Consortium for e-Resources in Agriculture (CeRA) of ICAR. Besides catering to the learning needs of scientists and the staff of the Institute, the library also attracts researchers from neighboring educational and research institutions, including Birla Institute of Technology, Ranchi University, Birsa Agricultural University and ICAR-Research Complex for Eastern Region-Regional Center, Ranchi; Indian Institute of Technology, Kharagpur; Rajendra Agricultural University, Samastipur; Patna University, Patna; National Institute of Technology, Jamshedpur etc.

The Quality Evaluation Laboratory of the Institute, caters to the quality control needs of the lac processing/lac product industries as well as exporters of lac/lac products. The lab has facilities for carrying out testing of lac/lac products as per BIS requirements.

The PME Cell provides access to internet and e-mail facilities for communication and information retrieval to the scientists. The Institute website at: http://ilri.ernet.in/~iinrg/ is a valuable source of information in the Institute.

Executive Summary

Biodiversity collection, conservation and evaluation

- Three new variants of *palas* (*Butea monosperma*) having yellow flower colour have been identified from Koinardih village of Jonha block, Ranchi (Jharkhand). Quantitative estimation of flavonoids and anthocyanins from *palas* variants for flower colour revealed that anthocyanin production is low despite of flavonoid production.
- Eight districts of Tripura State *viz*., West Tripura, Khowai, Unokoti, North Tripura, Dhalai, Gomati, South Tripura and Shipahijala were surveyed during October 2016 and no natural lac insect population observed. Lac insects from NEH region (Assam, Meghalaya and Nagaland) were evaluated during summer and rainy season crops. Average fecundity was higher in Assam stocks during summer, whereas average fecundity, cell and resin weight were more in Meghalaya stock during rainy season. Evaluation of *Kerria lacca* on *Calliandra calothyrsus*, *C. surinamensis* and *Dalbergia assamica* revealed *C. calothyrsus* as a good bushy lac host for lac cultivation for both the strains.
- Partial gene of decaprenyl diphosphate synthase, one of the key genes involved in sesquiterpene synthesis was cloned from the Indian lac insect, *Kerria lacca* (Kerr). The expression profile study revealed that this gene expression got up regulated in settled larvae and adult female lac insects in comparison to crawlers. One Suppression Subtraction Library (SSH) library was constructed to identify the differential gene expression in female lac insects compared to crawlers.
- Pruning of *swadi palas* in January gave significantly longer shoots and it was at par with February pruning. The winter *kusmi* broodlac output ratio was significantly higher in January and February pruning. A Pareto chart was prepared with lac and grain attributing traits in pigeon pea. Germplasm RCMP 4, ICPR 2671, RCMP 8, KA 9-1, KA 9-2, RCMP 11, Assam local 2, MAL 31 and RCMP 2 had more than 60 per cent contribution towards broodlac production among 28 germplasms evaluated for summer *rangeeni* lac crop. Genomic DNA isolation from pigeon pea was standardized using CTAB method to develop SSR marker for identification of high *rangeeni* lac yielding germplasm. The PCR conditions for SSR markers have been standardized with this genomic DNA.

Lac production system management

- Estimation of above and below ground carbon stock of six year old *semialata* plantation was estimated as 1583.33 kg carbon per hectare and 2229.6 kg carbon per hectare, respectively.
- Application of decomposed enriched lac mud as manure resulted in 18.9 and 19.4 per cent higher fruit yield of tomato and brinjal, respectively, and 9.4 per cent higher leaf yield of spinach over recommended practice. Relatively higher content of soil organic carbon, available nitrogen, phosphorus and zinc after harvest of vegetables was recorded in lac mud applied plots.
- Volatiles collected by extraction with hexane from nine different samples such as leaves of inoculated and un-inoculated host plant (*F. semialata*), lac insect (crawler, male, female during sexual maturity and adult female), whole lac insect body (lac insect with resin and wax), lac resin and wax, were detected using GC-MS. As a whole, volatiles like Decane, Dodecane, Hexadecane and Nonadecane which were present specifically in leaves of lac inoculated plants were also detected in adult female lac insect. It can be inferred that these compounds might be specifically induced by lac insect in host plants for its chemical communication with its associated fauna.
- 25 cleft grafting and 25 side grafting in *kusum* were also carried out during April as well as June. Overall success in cleft grafting and side grafting was 28 per cent and 32 per cent, respectively. Germination per cent of *kusum* seeds recorded in December revealed that sowing in June-July *i.e.* during ripening gives best (60% germination) result. Seedling mortality was significantly lower in lime applied polytubes (50% lower) compared to only FYM application. Inoculation of Azotobacter (A) and VAM (V) individually

raised the germination per cent to 34.7 from 21.6 and 36.9 from 19.4 per cent, respectively. However, phosphobacterin inoculation reduced germination to 19.4 per cent against 36.9 per cent in control. Seedling growth was found to be the highest in seeds of higher weight (13.47 g/ 10 seed). Bigger sized seeds (>0.5 g) germinated 46 per cent compared to 14 per cent small sized seeds.

- Demonstrations of technology on increasing *kusmi* lac yield on *ber* by application of chemical fertilizer were conducted at farmers' field on five locations. Lac yield ratio in fertilizer applied trees ranged from 11.1 to 17.8; while that for control was 3.8 to 7.4.

Pest and disease management

- Relative abundance and emergence profile of parasitoids and predators associated with lac insect were recorded during summer and rainy season crops of *rangeeni* strain revealed very low population of parasitoids (*Aprostocetus purpureus*, *Tachardiaephagus tachardiae* & *Parechthrodryinus clavicornis*) and the predator *Eublemma amabilis*. Level of parasitization recorded was lower in rainy season compared to summer season lac crop on *ber*. Maximum parasitization was during sexual maturity period on *ber* in summer and during crop maturity period on *ber* and *palas* in rainy season.
- Emergence profile of lac associated fauna was compared between *in situ* and laboratory caging. Numbers of parasitoids recorded was higher in *in situ* method compared to laboratory caging. Relative abundance of lac associated fauna compared under two different conditions *viz.*, spray with (Fipronil + Chlorothalonil) and Chlorothalonil only revealed that Fipronil is effective against *A. purpureus*, *P. clavicornis* and *E. amabilis* but not against *T. tachardiae*.
- A new insecticide Augusta™ (active ingredient natural lactose 0.6% and natural alkaloid 0.3%) has been evaluated on lepidopteron pest *E. amabilis* and *P. pulverea* through dipping of broodlac. Four formulations evaluated (0.5, 1.0, 1.5 and 2.0) for 5, 10 and 15 minutes durations indicated safety of this insecticide to lac insect. Significant reduction in the population of lepidopteron pests was also recorded.

Tapping, processing and characterization of NRGs

- Alditol acetate and uronic acid derivatives synthesized from different grades of gum *ghatti* (*Anogeissus latifolia* Wall.) and *jhingan* gum (*Lannea coromandelica*) along with standard monosaccharides were analyzed by GC-MS. The anionic (carboxymethyl), non-ionic (Hydroxypropyl) and cationic (Hydroxypropyl triammonium chloride) derivatives of *guar* gum were synthesized by semi-dry and non-aqueous method involving minimum use of organic solvent.
- The samples of gum *Karaya* kept in cold condition with normal seal and vacuum packaged nitrogen seal showed higher acid value (%) and swelling index as compared to the samples kept at in ambient condition with normal seal and vacuum packaged nitrogen seal.
- Shellac modified in aqueous and non-aqueous solvent system was used to develop coating formulations for paper packaging. The formulations were found to be smooth, uniform and glossy and characterized by FT-IR, DSC, mechanical properties, contact angle measurement and SEM.
- Yield of DDL was found upto 75% by using thick cloth for filtration of wax and charcoal in solvent ratio 1: 6 and above. Fresh charcoal reduced the colour of seedlac from 12 to 4.

Application and product development

- The synthesized cross-linked *guar* gum hydrogels were characterized by absorption studies, FT-IR, SEM, TGA/DTA analyses. Dye removal efficiency of the synthesized hydrogels was also studied. Lyophilized *acacia* gum-based silver nanoparticles (AgNPs) were characterized by UV-VIS, FT-IR Spectroscopy, Particle Size Analysis, Zeta Potential, Atomic Force Microscopy (AFM) and SEM.
- Different modified derivatives of gum *karaya*, gum *arabic* and gum *ghatti* were synthesized as an adsorbent for the removal of heavy metals. *Moringa* gum and *guar* gum based hydrogel polymers were synthesized by using varying concentrations of monomer, cross-linker and initiator. Chromium (VI) metal absorption at different pH and adsorbent concentration was studied.

Capacity building and training

- Eighteen Farmers' Training Programmes on Scientific lac cultivation, processing and utilization were organized for 566 farmers from four States *viz.*, Jharkhand, Chhattisgarh, West Bengal and Madhya Pradesh. Ten Master Trainers' Training Programmes on Scientific lac production, processing and uses were organized for 332 stakeholders from Jharkhand, Andhra Pradesh, Karnataka, Assam, Chhattisgarh and West Bengal.
- Five Educational programmes on Production, processing and application of natural resins and gums were conducted for 171 UG/PG students from Sam Higginbottom Institute of Agriculture Science & Technology, Allahabad; Institute of Agriculture Science, BHU, Varanasi (Uttar Pradesh); NG Ranga Agricultural University (Andhra Pradesh); St. Xavier's College, Ranchi (Jharkhand) and Guru Ghasidas University, Bilaspur (Chhattisgarh). A Model Training Course on Natural Resins and Gums: Agribusiness Modules for Skill & Entrepreneurs Development was conducted and 23 stakeholders participated under this skill oriented course. Two Refresher Courses on Scientific lac cultivation, processing and uses were organized and a total of 57 persons participated from Jharkhand.
- Fifteen lac based product demonstration training programmes of various durations (3-10 days) were organized for 24 self sponsored stakeholders from different States on Lac processing and product development.
- Fourteen on-farm training programmes were organized for 1080 stakeholders of Jharkhand. A total of 856 participants from various districts of Meghalaya and Jharkhand State benefitted from on-farm motivational/supplementary training programme. Fourteen in-campus one day orientation programmes on Natural resins and gums were organized; 3471 farmers, school/college students and executives of Jharkhand, Odisha and West Bengal visited the Institute.

Field demonstration, technical advisory and extension activities

- Five field demonstrations on Scientific lac cultivation technologies and seven method demonstration on broodlac dipping in pesticides to preserve the crop from pest incidence were conducted at various places in Jharkhand, Bihar and West Bengal.
- To showcase the latest technologies of the Institute, experts participated in eight Exhibition / kisan melas wherein around 164000 visitors were acquainted with the different activities of Institute and also participated in 12 *kisan gosthi* organized in different districts of Jharkhand & Odisha benefitting around 2946 participants.
- An ICT enabled One to One Programme (OTOP), Market Oriented Technical Advisory Services (MOTAS), diagnostic and crop monitoring visits benefited more than 200 farmers, processors, industrialists, lac businessmen and lac handicraft entrepreneurs from 13 States.

Technology adoption, impact assessment and market research activities

- A small scale lac processing unit was established in Chirang district of Assam (facilitated by Aie Valley Lac Producer & Allied Agro Marketing Co-operative Society Ltd.) to demonstrate the lac processing technology in NEH region. An entrepreneur from Sakti, Chhattisgarh started production of 2.5 tons of bleached lac/ month and a younger entrepreneur started production of 2.0 tons of aleuritic acid at M/s KD Udyog, Nadia, West Bengal after receiving training at this Institute.
- An impact analysis revealed that adoption of improved method of pruning, broodlac inoculation, *phunki* removal, pest management and post harvest management was increased. Impact of adoption level resulted as increased productivity level across various category of households.
- Production of lac increased by 10.41% over the last year. However, total production of NRGs decreased about 25% from 1120124 tons in 2014-15 to 844646 tons in 2015-16. Price of *guar* gum remained stable at lower level during 2016-17.

कार्यकारी सारांश

जैवविविधता संग्रह, संरक्षण एवं मूल्यांकन

- राँची (झारखंड) के जोन्हा प्रखंड के कोइनारडीह ग्राम में पीले फूल वाले पलास (*ब्यूटिया मोनोस्पर्मा*) के तीन नये परिवर्त की पहचान की गई। फूलों के रंग के लिए पलास परिवर्त से सुगंधित पदार्थ एवं रंग के मात्रात्मक अनुमान से पता चलता है कि सुगंधित पदार्थ के उत्पादन के बावजूद भी रंजकण के उत्पादन कम हैं।

- त्रिपुरा राज्य के आठ जिलों पश्चिम त्रिपुरा, खोवई, उनोकाटि, उत्तर त्रिपुरा, धलाई, गोमती, दक्षिण त्रिपुरा एवं शिपाहीजाला का सर्वे किया गया। वहाँ लाख की कोई प्राकृतिक आबादी नही देखी गई। ग्रीष्मकालीन एवं वर्षा ऋतु की फसल के दौरान उत्तर पूर्व पर्वतीय क्षेत्र (असम, मेघालय एवं नागालैंड) के लाख कीटों का मूल्यांकन किया गया। गर्मी के समय असम स्टॉक में औसत जननशीलता उच्चतर थी, जबकि मेघालय स्टॉक में वर्षा ऋतु में औसत जननशीलता, कोशिका एवं राल का वजन ज्यादा था। *कैलिएन्ड्रा कैलोथिरसस, सी सुरीनामेंसिस एवं डलवर्जिया असमिका* पर *केरिया लैका* के मूल्यांकन से पता चलता है कि *सी कैलोथिरसस* दोनों उपजातियों के लिए लाख की खेती हेतु अच्छा झाड़ीदार परिपालक है।

- सेस्क्यूटर्पिन संश्लेषण से जुड़े एक महत्वपूर्ण जीन डिकाप्रेनील डाइफॉस्फेट सिन्थेज के आंशिक जीन का भारतीय लाख कीट, *केरिया लैका* (*केर*) से प्रतिकृति (*क्लोन*) बनाया गया। एक्सप्रेशन विवरण अध्ययन से पता चलता है कि रेंगने वाले कीटों की तुलना में स्थापित लार्वा एवं परिपक्व मादा लाख कीटों में जीन की अभिव्यक्ति नियमित हो गई। रेंगने वाले कीटों की तुलना में मादा लाख कीटों में विभिन्न जीन अभिव्यक्तिकरण की पहचान के लिए एक एस एस एच लाइब्रेरी का निर्माण किया गया।

- स्वादी पलास में जनवरी में छंटाई करने से प्ररोह उल्लेखनीय रूप से लम्बे हुए एवं यह फरवरी में की गई छंटाई के समान थे। जनवरी एवं फरवरी में की गई छंटाई में शरदकालीन कुसमी बीहनलाख का उत्पादन अनुपात उल्लेखनीय रूप से उच्चतर था। लाख एवं अरहर की अनाज संबंधी विशेषताओं के साथ एक पैरेटो चार्ट बनाया गया। ग्रीष्मकालीन रंगीनी फसल के लिए 28 जननद्रव के मूल्यांकन से पता चलता है कि बीहनलाख उत्पादन के लिए 60 प्रतिशत से अधिक योगदान जननद्रव आर सी एम पी 4, आइ सी पी आर 2671 आर सी एम पी 8, के ए 9-1, के ए 9-2, आर सी एम पी 11, असम स्थानीय 2, एम ए एल 31 एवं आर सी एम पी 2 का रहा। उच्च रंगीनी लाख उत्पादक जननद्रव की पहचान के लिए एस.एस.आर. मार्कर विधि विकसित करने हेतु सी.टी.ए.बी. विधि का प्रयोग कर अरहर से जीनोमिक डी.एन.ए. पृथक्करण का मानकीकरण किया गया। इस जीनोमिक डी.एन.ए. के साथ एस एस आर मार्कर के लिए पी.सी.आर. स्थितियां मानकीकृत की गई।

लाख उत्पादन पद्धति प्रबंधन

- छः वर्ष पुराने *सेमियालता* बगान के उपर एवं नीचे भूमिगत कार्बन स्टॉक के आकलन में प्रति हे. क्रमशः 1583.33 किग्रा एवं 2229.6 किग्रा कार्बन का अनुमान लगाया गया।

- सड़े हुए परिष्कृत लाख कीचड़ का खाद के रूप में प्रयोग करने पर अनुसंशित तरीके की तुलना में टमाटर एवं बैंगन में क्रमशः 18.9% एवं 19.4% उच्चतर उपज तथा पालक में 9.4% ज्यादा उपज प्राप्त हुयी। लाख कीचड़ प्रयुक्त खेत में फसल कटाई उपरान्त मृदा कार्बनिक कार्बन, उपलब्ध नाइट्रोजन, फॉस्फोरस एवं जिंक का अपेक्षाकृत उच्चतर अंश रिकॉर्ड किया गया।

- नौ विभिन्न नमूनों जैसे संचारित एवं गैरसंचारित लाख परिपालक पौधों (*एफ सेमियालता*) के पत्ते, लाख कीट (लैंगिक परिपक्वता के दौरान रेंगने वाले कीट, नर, मादा तथा परिपक्व मादा), लाख कीट का पूरा शरीर (राल एवं मोम के साथ लाख कीट), लाख राल एवं मोम से हेक्सेन के साथ निष्कर्षण द्वारा संग्रहित वाष्पशील का जी सी-एम एस का उपयोग कर परीक्षण किया गया। सम्पूर्ण रूप से डिकेन, डोडिकेन, हेक्साडिकेन एवं नोनाडिकेन जैसे वाष्पशील विशेषकर लाख संचारित पत्तियों के साथ-साथ वयस्क मादा लाख कीट में उपस्थित पाए गए। ऐसा कहा जा सकता है कि अपने सम्बद्ध जीन के साथ रासायनिक संचार के तहत लाख कीट द्वारा विशेष रूप से इन यौगिकों को परिपालक पौधों में प्रवेश कराया जाता है।

- अप्रैल एवं जून के दौरान कुसुम में 25 क्लेफ्ट कलम रोपण तथा 25 साइड कलम रोपण किया गया। कुल मिलाकर क्लेफ्ट कलम रोपण एवं साइड कलम रोपण में क्रमशः 28 प्रतिशत एवं 32 प्रतिशत सफलता मिली। जून-जुलाई में यानि पकने पर लगाए गए कुसुम बीजों का दिसम्बर में अंकुरण प्रतिशत जाँच करने से पता चलता है कि परिणाम सबसे अच्छा (60% बीजों का अंकुरण) रहा। केवल एफ वाइ एम प्रयोग की तुलना में चुना प्रयोग किए गए पौलीबैगों में विचड़ों की मरणशीलता उल्लेखनीय रूप से कम थी। अजोटोबैक्टर (ए) एवं वी ए एम (वी) के अलग-अलग संचारण से अंकुरण के प्रतिशत में क्रमशः 21.6 से 34.7% एवं 19.4% से 36.9% की वृद्धि हुई। हालांकि नियंत्रण के 36.9% की तुलना में फॉस्फोबैक्टेरिन के संचारण से अंकुरण कम होकर 19.4% हो गया। उच्चतर वजन वाले (13.47 ग्रा./10 बीज) बीजों के विचड़ो की वृद्धि उच्चतम थी। छोटे आकार के बीजों के 14% की तुलना में बड़े आकार के (> 0.5 ग्रा) बीजों का अंकुरण 46% रहा।
- किसानों के खेत में पाँच स्थलों पर रासायनिक उर्वरक का प्रयोग कर बेर पर कुसमी लाख के बढ़ते हुए उत्पादन की प्रौद्योगिकी का प्रदर्शन किया गया। नियंत्रण के 3.8 से 7.4 की तुलना में उर्वरक का प्रयोग किए गए वृक्षों का लाख उत्पादन अनुपात 11.1 से 17.8 रहा।

नाशीकीट एवं रोग प्रबंधन

- ग्रीष्म एवं वर्षा ऋतु की रंगीनी उपजाति की फसल के दौरान लाख कीट से जुड़े परजीवियों एवं परभक्षियों की बहुलता एवं आविर्भाव विवरण की जाँच से परजीवियों (*एप्रोस्टोसिटस परप्यूरियस, टैकार्डीफेगस टेकार्डी* एवं *पैरेन्क्थ्रोड्राइनस क्लेविकॉर्निस*) तथा परभक्षी *यूब्लिमा एमाबिलिस* की न्यून आबादी का पता चला। बेर पर ग्रीष्मकालीन लाख की फसल की तुलना में वर्षा ऋतु में परजीवीकरण का स्तर कम था। गर्मी के समय में बेर पर लैंगिक परिपक्वता की अवधि में एवं वर्षा ऋतु मे बेर तथा पलास पर फसल की परिपक्वता के समय अधिकतम परजीवीकरण रिकॉर्ड किया गया।
- लाख से जुड़े प्रतिस्थाने एवं प्रयोगशाला में रखे गए जीवों के आविर्भाव विवरण की तुलना की गई। प्रयोगशाला में रखे गए की तुलना में प्रतिस्थाने परजीवियों की संख्या उच्चतर थी। दो अलग-अलग स्थितियों जैसे फिप्रोनील + क्लोरोथैलोनील एवं केवल क्लोरोथैलोनील के छिड़काव के अन्तर्गत लाख से जुड़े जीवों की सापेक्षिक प्रचुरता की तुलना करने पर पता चला कि फिप्रोनील *ए परप्यूरियस, पी क्लेविकॉर्निस* एवं *ई एमाविलीस* पर प्रभावी है तथा *टी टेकार्डी* के उपर प्रभावी नहीं है।
- एक नये कीटनाशी अगस्ता टी एम (सक्रिय अवयव लैक्टोज 0.6% एवं प्राकृतिक अल्कल्वायड 0.3%) में बीहनलाख को डूबाकर लेपिडोप्टेरन नाशीकीट *इ एमाविलिस* एवं *पी पल्वेरिया* पर इसका मूल्यांकन किया गया। चार सुत्रणों (0.5, 1.0, 1.5 एवं 2.0) का मूल्यांकन किया गया तथा 15 मिनट अवधि में लाख कीट के प्रति कीटनाशी सुरक्षित पाया गया। लेपिडोप्टेरन नाशीजीव की आबादी में उल्लेखनीय कमी देखी गई।

प्राकृतिक राल एवं गोंद का संग्रहण, प्रसंस्करण एवं अभिलक्षण वर्णन

- विभिन्न श्रेणी के घट्टी गोंद (*एनोजीसस लैटिफोलिया वाल*) एवं झींगन गोंद (*लैनिया कोरोमंडेलिका*) से ऐल्डीटॉल एसीटेट एवं युरोनिक अम्ल व्युत्पन्न का संश्लेषण किया गया, साथ हीं मानक मोनोसेकेराइड का जी सी एम एस द्वारा विश्लेषण किया गया। कार्बनिक विलायक का न्युनतम उपयोग कर अर्द्धशुष्क एवं गैर जलीय विधि द्वारा ग्वार गोंद के अनिओनिक (कार्बोग्जीमिथाईल), गैर आयोनिक (हाइड्रोग्जी प्रोपाइल) एवं कैटायनिक (हाइड्रोग्जी प्रोपाइल ट्राई अमोनियम क्लोराइड) व्युत्पन्नों का संश्लेषण किया गया।
- कमरे के तापमान में सामान्य सील एवं निर्वात पैक नाइट्रोजन सील के अन्तर्गत रखे गए कराया गोंद के नमूने की तुलना में ठंडी स्थितियों में सामान्य सील एवं निर्वात पैक नाइट्रोजन सील के कराया गोंद का अम्ल मान (%) एवं फैलाव सूचकांक उच्चतर था।
- जलीय एवं गैरजलीय विलायक पद्धति में रूपांतरित चपड़ा का कागज की पैकेजिंग के लिए लेपन सुत्रण विकसित करने के लिए उपयोग किया गया। सुत्रण चिकना, समान एवं चमकदार पाया गया तथा इसका एफ टी-आई आर, डी एस सी, यांत्रिक गुणों, संपर्क कोण माप एवं एस ई एम द्वारा अभिलक्षण वर्णन किया गया।

- विलायक अनुपात 1:6 एवं उपर की स्थिति में मोम एवं चारकोल के छनन के लिए मोटे कपड़े का उपयोग कर डी डी एल की प्राप्ति 75% तक पायी गई। ताजा चारकोल से चपड़े के रंग में बारह से चार की कमी आई।

प्रयोग एवं उत्पाद विकास

- अवशोषण अध्ययन, एफ टी-आई आर, एस ई एम, टी पी ए/डी टी ए विश्लेषण द्वारा संश्लेषित क्रॉस-लिंक्ड ग्वार गोंद हाइड्रोजेल का अभिलक्षण वर्णन किया गया। संश्लेषित हाइड्रोजेल की रंग निकालने की क्षमता का भी अध्ययन किया गया। लाइफिलाइज्ड अकेसिया गोंद आधारित रजत सूक्ष्मकक्षों (ए जी एन पी एस) का यू वी-वी आई एस, एफ टी-आई आर स्पेक्ट्रोस्कोपी, कण आकार विश्लेषण, जेटा पोटेन्सियल, आण्विक बल सूक्ष्मदर्शी (ए एफ एम) एवं एस इ एम के द्वारा अभिलक्षण वर्णन किया गया।

- कराया गोंद, अरबी गोंद एवं घट्टी गोंद के विभिन्न रूपान्तरित व्युत्पन्न के भारी धातुओं को निकालने के लिए अवशोषक के रूप में संश्लेषण किया गया। मोनोमर, क्रॉसलिंकर एवं आरंभक के अलग-अलग सांद्रण का उपयोग कर मोरींगा गोंद एवं ग्वार गोंद आधारित हाइड्रोजेल का संश्लेषण किया गया। विभिन्न पी एच एवं अधिशोषक सांद्रण पर क्रोमियम (VI) का अध्ययन किया गया।

क्षमता निर्माण एवं प्रशिक्षण

- चार राज्यों जैसे झारखंड, छतीसगढ़, पश्चिम बंगाल एवं मध्य प्रदेश के 566 किसानों को 18 प्रशिक्षण कार्यक्रम के अन्तर्गत लाख की वैज्ञानिक खेती, प्रसंस्करण एवं उपयोग का प्रशिक्षण दिया गया। झारखंड, आन्ध्र प्रदेश, कर्नाटक, असम, छतीसगढ़ एवं पश्चिम बंगाल के 332 पणधारियों के लिए लाख का वैज्ञानिक उत्पादन, प्रसंस्करण एवं उपयोग संबंधी प्रशिक्षक प्रशिक्षण कार्यक्रम आयोजित किया गया।

- सैम हिगीनबॉटम कृषि विज्ञान एवं प्रौद्योगिकी संस्थान, इलाहाबाद; कृषि विज्ञान संस्थान, बी एच यू, वाराणसी (उत्तर प्रदेश); एन जी रंगा कृषि विश्वविद्यालय (आन्ध्र प्रदेश); संत जेवियर महाविद्यालय, राँची (झारखंड) एवं गुरू घासीदास विश्वविद्यालय, बिलासपुर (छत्तीसगढ़) के 171 स्नातक/स्नातकोत्तर छात्र/छात्राओं के लिए प्राकृतिक राल एवं गोंद के उत्पादन, प्रसंस्करण संबंधी पाँच शैक्षणिक कार्यक्रम संचालित किये गए। प्राकृतिक राल एवं गोंद : कौशल एवं उद्यमिता विकास के लिए कृषि व्यापार मॉड्यूल्स विषय पर एक मॉडल प्रशिक्षण पाठ्यक्रम संचालित किया गया तथा कौशल से जुड़े इस कार्यक्रम में 23 पणधारियों ने भाग लिया। लाख की वैज्ञानिक खेती, प्रसंस्करण एवं उपयोग पर दो पुनश्चर्या पाठ्यक्रम आयोजित किए गए एवं इसमें झारखंड के 57 व्यक्तियों ने भाग लिया।

- विभिन्न राज्यों के 24 स्वप्रायोजित पणधारियों के लिए लाख प्रसंस्करण एवं उत्पाद विकास पर अलग-अलग अवधि (3-10 दिन) के लाख आधारित पन्द्रह प्रदर्शन प्रशिक्षण कार्यक्रम आयोजित किए गए।

- झारखंड के 1080 पणधारियों के लिए चौदह प्रक्षेत्र प्रशिक्षण कार्यक्रम आयोजित किए गए। मेघालय एवं झारखंड के विभिन्न जिलों के 856 प्रतिभागियों ने प्रक्षेत्र प्रोत्साहन/पूरक प्रशिक्षण कार्यक्रम का लाभ उठाया। परिसर में प्राकृतिक राल एवं गोंद पर चौदह एक दिवसीय अभिविन्यास कार्यक्रम आयोजित किये गए, जिसमें झारखंड, ओडीशा एवं पश्चिम बंगाल के 3471 किसानों, विद्यालय/महाविद्यालय के छात्रों एवं अधिकारियों ने भाग लिया।

प्रक्षेत्र प्रदर्शन, तकनीकी परामर्श एवं प्रसार गतिविधि

- झारखंड, बिहार एवं पश्चिम बंगाल के विभिन्न स्थानों पर लाख की वैज्ञानिक कृषि प्रौद्योगिकी का पाँच एवं नाशकजीव से सुरक्षा के लिए कीटनाशियों में बीहनलाख को डुबाने की विधियों का सात प्रदर्शन किया गया।

- संस्थान की नई प्रौद्योगिकियों के प्रदर्शन के लिए विशेषज्ञों ने आठ प्रदर्शनी/किसान मेलों में भाग लिया, जहाँ संस्थान के स्टॉल पर 164000 आंगतुकों ने संस्थान के विभिन्न गतिविधियों की जानकारी प्राप्त की तथा झारखंड एवं ओडीशा के विभिन्न जिलों में 12 किसान गोष्ठी आयोजित की गई, जिसमें 2946 प्रतिभागियों ने लाभ उठाया।

- आई सी टी सुविधा की वन टु वन प्रोग्राम (ओ टी ओ पी), बाजार आधारित तकनीकी सेवाएं (एम ओ टी ए एस) फसल निरीक्षण एवं जाँच संबंधी दौरों से 13 राज्यों के 200 किसानों, प्रसंस्करणकर्त्ताओं, उद्यमियों, लाख व्यापारियों एवं हस्तशिल्प उद्यमियों को लाभान्वित किया गया।

प्रौद्योगिकी अंगीकरण, प्रभाव मूल्यांकन एवं बाजार अनुसंधान गतिविधियां

- उत्तर पूर्व पर्वतीय क्षेत्र में लाख प्रसंस्करण प्रौद्योगिकी के प्रदर्शन के लिए असम के चिरांग जिले में एक लघुस्तरीय लाख प्रसंस्करण इकाई (ए आई ई वैली लैक प्रोड्युसर एन्ड एलाइड एग्रो मार्केटिंग कोऑपरेटिव सोसाइटी लि. द्वारा सुविधा प्रदत्त) की स्थापना की गई। संस्थान से प्रशिक्षण प्राप्त करने के पश्चात् सक्ति, छत्तीसगढ़ के एक उद्यमी ने 2.5 टन विरंजित लाख/माह उत्पादन आरंभ किया है एवं सर्वश्री के डी उद्योग, नादिया, पश्चिम बंगाल के एक युवा उद्यमी ने 2.0 टन एल्यूरिटिक अम्ल का उत्पादन आरम्भ किया।
- प्रभाव विश्लेषण अध्ययन से पता चलता है कि छंटाई, बीहनलाख संचारण, फुंकी हटाना, नाशीजीव प्रबंधन एवं कटाई उपरांत प्रबंधन में वृद्धि हुई है। विभिन्न श्रेणी के परिवारों में अंगीकरण के प्रभाव से उत्पादन स्तर में वृद्धि हुई है।
- विगत वर्ष में लाख के उत्पादन में 10.41% वृद्धि हुई है। हालांकि वर्ष 2014-15 के 1120124 टन की तुलना में वर्ष 2015-16 में 844646 टन के साथ प्राकृतिक राल एवं गोंद के उत्पादन में 25% की कमी आई है। वर्ष 2016-17 में ग्वार गोंद का मूल्य निचले स्तर पर बना रहा।

Research Accomplishments

Lac Production

1. Productivity and Quality Improvement

1.1 Collection, conservation, characterization and documentation of lac insect and host plant bio-diversity and potentiality trials

Survey for identification of lac insects/host plants biodiversity

Three new variants of *palas (Butea monosperma)* having yellow flower colour have been identified from Koinardih village of Jonha block, Ranchi (Jharkhand) in a survey conducted on 19/03/2016 (Fig. 1).

Eight districts of Tripura *viz.*, West Tripura, Khowai, Unokoti, North Tripura, Dhalai, Gomati, South Tripura and Shipahijala were surveyed during October 23-27, 2016. Lac host plants such as *Albizzia saman, Cajanus cajan, Ficus spp, Malvaviscus penduliflorus, Mallotus philippensis, Peltophorum ferrugenium,* and *Ziziphus mauritiana* were observed during the survey. No natural lac insect population observed.

Fig. 1: Yellow coloured flowers of *palas* from Koinardih village, Jonha block, Ranchi (Jharkhand)

Documentation of lac host biodiversity

Flower morphology of *F. grahamiana* and variation in pod shape of *galwang (Albizia lucida)* was documented keeping its possible role in lac production in future.

Characterization of lac host biodiversity

Pod characterization in *Flemingia* species

F. macrophylla pods are green in colour when immature and turn brown towards maturity (Fig. 2a). Pods are inflated and 17mm x 7mm in size. Top portion of pods of *F. semialata* are red in colour while base remains green (Fig. 2b). Pods are narrow, elongated, inflated and 13 mm x 6 mm in size. Pods turn brown towards maturity. In *F. strobilifera* var. *bracteata* pods are green in colour having red coloured mosaic pattern on whole surface of the pods when immature (Fig. 2c). Pods are inflated, turn grey coloured towards maturity and 12 mm x 10 mm in size. In *F. chapper* pods are green in colour when immature and turn black towards maturity (Fig. 2d). Pods are inflated and 10 mm x 7 mm in size. In *F. stricta* pods are green in colour having red stripe towards base while tip remains green in colour (Fig. 2e). The pattern remains same towards maturity. Pods are inflated and 10 mm x 5 mm in size.

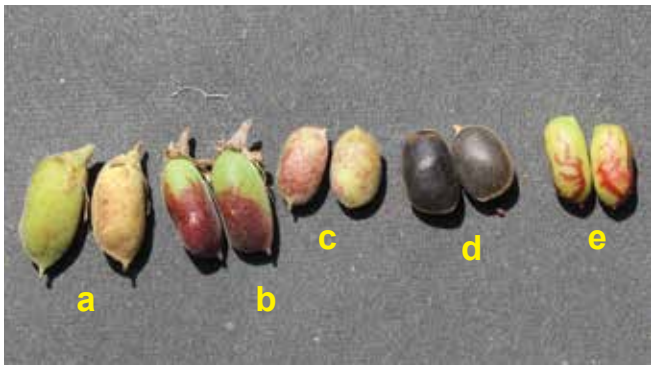


Fig. 2: Pod characterization in *Flemingia* species (a) *F. macrophylla* (b) *F. semialata* (c) *F. strobilifera* (d) *F. chapper* (e) *F. stricta*

Studies on colour pigments of the *palas* flower colour variants

Flavonoids and anthocyanins were estimated in different shades of *palas* flower colours *viz.*, orange-yellow (V1, V2, V3), yellow (V4), white (V5) and compared with scarlet (V6) which is naturally occurring flower colour. The study revealed that the negative value for anthocyanin production was obtained in white (V5) and one orange-yellow (V2) coloured flowers. In other orange-yellow variants, V1 and V3 got positive value. Variant V4 which is pure yellow also got value less than 0.5. The variant V6 got the highest positive value. For flavonoids, the highest value was recorded for scarlet V6. For orange-yellow (V1, V2, V3) the value ranges from 17-24 mg/L. Lowest value for flavonoids was recorded for white

variant V5 and yellow variant V4. This study indicated that those variants which obtained negative to 1 values for anthocyanin production were unable to convert flavonoids to anthocyanins regardless of flavonoid production. In orange-yellow variants, the conversion of flavonoids to anthocyanins was ranged from 2 to 9 per cent. Though the scarlet produces maximum flavonoid content amongst all the variants, conversion percentage recorded was 6 per cent. Thus, the study revealed that intensity of the flower colour variation in *palas* could be due to interplay of flavonoid content and its extent of conversion to anthocyanins. Therefore, the study will help in solving the long standing mystery of flower colour variation in *palas* and conserving these elite germplasm (Fig. 3).

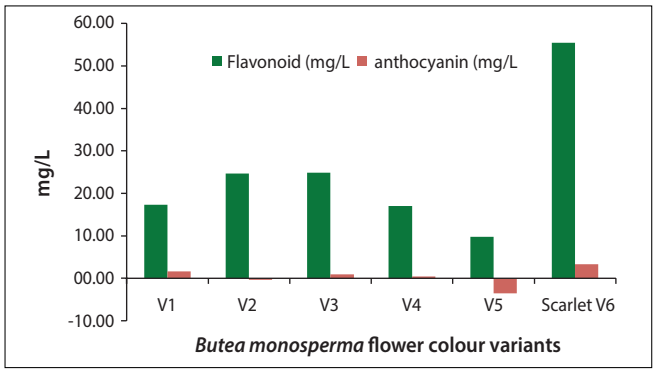


Fig. 3: Flavonoids and anthocyanins estimation in *B. monosperma* flower colour variants

Molecular Characterization of lac host plants

Protein profiling of different colour *palas* flowers (yellow, golden yellow, chrome yellow, mustard yellow and scarlet) have been carried out on SDS-PAGE gels. The protein profile does not reveal any difference between different colour *palas* flowers.

Barcoding of five *Flemingia* species (*Flemingia semialata, Flemingia stricta, Flemingia chappar, Flemingia strobilifera var. bracteata* and *Flemingia macrophylla*) have been carried out with two primers (*atpF*-H and rbcL).

Evaluation of lac insect stocks

Lac insect stocks collected from NEH region (Assam, Meghalaya and Nagaland) were evaluated during *baisakhi* (summer) crop, 2016. Average density of settlement was more (66 per sq cm) with 17 per cent mortality on Nagaland stock. Male sex ratio was more than optimum and ranged from 58-73 per cent on all the three stocks. Average fecundity was more (249 nos) in Assam stocks and no difference in cell weight and resin weight from all three stocks (Fig. 4). Evaluation of lac insect stocks collected from NEH region was continued during *katki* (rainy) crop, 2016. Average density of settlement was more (132.6 per sq cm) with 10.56 per cent initial mortality in Meghalaya stocks. Male sex ratio was ranged between 35-49 per cent on all the stocks. Average fecundity (323 nos.), cell weight (24.26 mg) and resin weight (20.30 mg) was significantly more in Meghalaya than other stocks (Fig. 5).

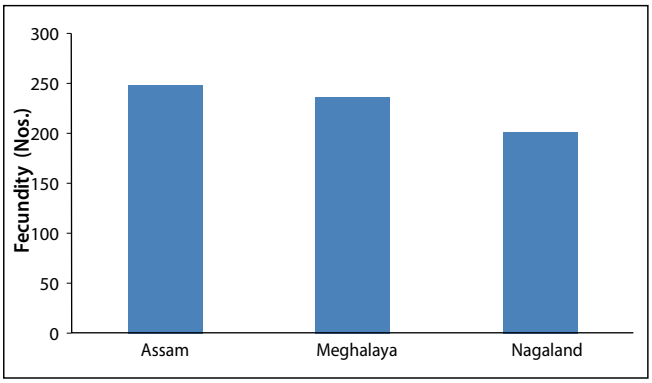


Fig. 4: Average fecundity of lac insects during summer (*baisakhi*) crop, 2016

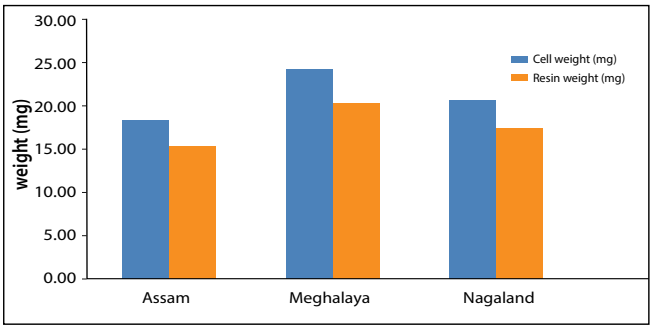


Fig. 5: Cell and resin weight of lac insects during rainy (*katki*) crop, 2016

Evaluation of lac insect on rain tree (*A. saman*)

Evaluation of lac insect was initiated during *katki*, 2016. Average initial settlement density (48.6 per sq cm), initial mortality (23.59 per cent), sex ratio (12 per cent), fecundity (212 nos.) and cell and resin weight (13.3 and 10.3 mg) was recorded on rain tree.

Potentiality trials of *K. chinensis* and *K. lacca* on new lac host plants

Evaluation of *K. chinensis* and *K. lacca* (*kusmi* and *rangeeni*) was carried out during both crop cycles of 2016. Broodlac was inoculated and biological attributes *viz.*, pre-harvest and post-harvest parameters were recorded on *Calliandra calothyrsus*, *C. surinamensis*, *Dalbergia assamica* and *M. penduliflorus.*

Evaluation of *K. chinensis* and *K. lacca* (*kusmi* and *rangeeni*) during summer 2016

Initial settlement density of *K. chinensis* was the highest with lesser mortality in *C. calothyrsus* (104 per sq cm and 6.6 per cent) followed by *M. penduliflorus* and *D. assamica*. Sex ratio (male per cent) of *K. chinensis* was more than optimum ranged from 66-73 per cent in all the hosts. Post harvest parameters could not be recorded due to more sex ratio and lac insect mortality during summer crop, 2016.

Evaluation of *K. lacca* (*rangeeni*) during summer (*baisakhi*) crop, 2016

Settlement density of *K. lacca* (*rangeeni*) was more (89.67 per sq cm) on *C. calothyrsus* followed by *D. assamica* and *C. surinamensis*. Initial mortality and sex ratio (male per cent) ranged between 14-19 and 46-64 per cent, respectively in all the host plants. Average fecundity (297 nos), cell and resin weight (12.33 and 9.77 mg) was more on *C. calothyrsus* followed by *D. assamica* and *C. surinamensis* (Fig. 6). Yield attributes, *viz*., Broodlac, rejected lac, scraped lac and broodlac ratio were obtained on *C. calothyrsus* (2.05kg, 182 gram 139gram and 3.61 per plant). However, only rejected and scraped lac were obtained from *D. assamica* and *C. surinamensis.*

Evaluation of *K. lacca* (*kusmi*) during summer (*jethwi*) crop, 2016

Initial settlement density of *K. lacca* (*kusmi*) was higher (87.47 per sq cm) with 49 per cent mortality on *D. assamica* than the other hosts. Sex ratio ranged between 35-47 per cent (Fig. 7). No difference was observed for average fecundity, cell and resin weight on *C. calothyrsus* and *D. assamica*. Yield attributes *viz*., broodlac, broodlac per meter lac encrustation, rejected lac and broodlac ratio obtained were 894g, 73g, 131g, and 2.25 per plant on *C. calothyrsus and* 266g, 31g, 63g and 1.42 per plant on *D. assamica,* respectively.

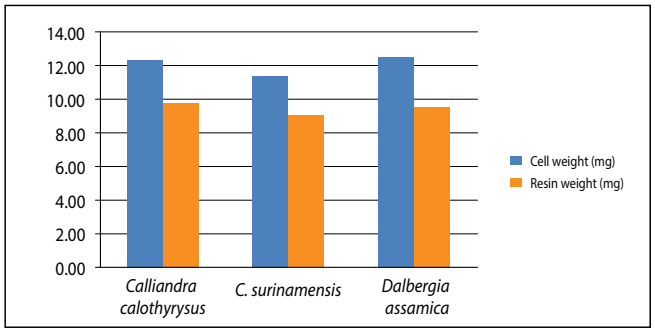


Fig. 6: Cell and resin weight of *K. lacca* (*rangeeni*) during summer (*baisakhi*) crop, 2016

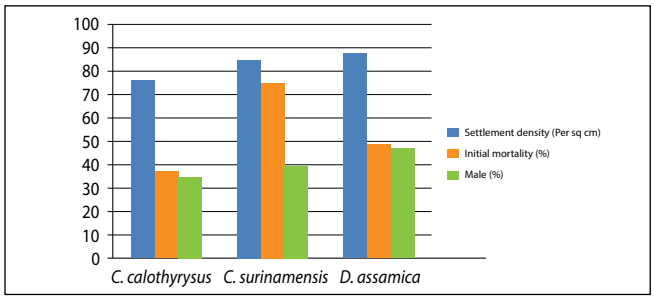


Fig. 7: Pre harvest parameters of *K. lacca* (*kusmi*) during *jethwi* crop, 2016

Evaluation of *K. chinensis* during rainy season (2016)

Settlement density of *K. chinensis* was more with lesser mortality on *M. penduliflorus* (89.33 per sq cm and 9.3 per cent) followed by *C. calothyrsus* and *D. assamica*. Sex ratio and post harvest parameters could not be recorded due to lac insect heat mortality at one month after inoculation during rainy crop 2016.

Evaluation of *K. lacca* (*rangeeni*) during rainy (*katki*) crop, (2016)

Settlement density and initial mortality of *K. lacca* (*rangeeni*) were more on *C. calothyrsus* (72.27 per sq cm and 43 per cent) followed by *D. assamica* and *C. surinamensis*. Optimum sex ratio was recorded ranged 30-36 per cent. Cell and resin weight (16 and 11) was more in *C. calothyrsus* than *D. assamica* (Fig. 8). Fecundity was less in both the host. Rejected lac was more than broodlac and broodlac ratio (1.6 per plant) on *C. calothyrsus* due to parasitization during sexual maturity period. However, only rejected lac (50 and 67 g/ plant), scraped lac (5 and 10 g/plant) were obtained from *C. surinamensis* and *D. assamica*, respectively.

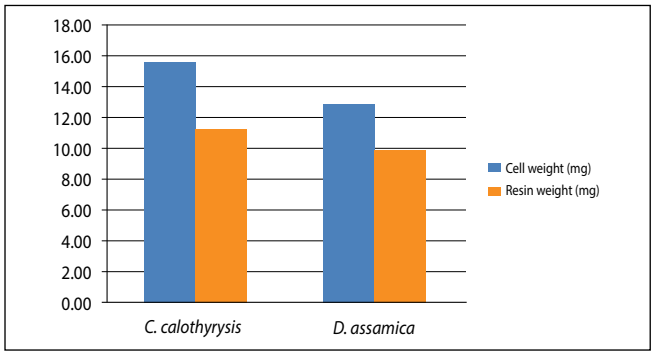


Fig. 8: Cell and resin weight of *K. lacca* (*rangeeni*) during (*katki*) crop, 2016

Comparison between *K. lacca* (*rangeeni* and *kusmi*) during summer 2016

C. calothyrsus is proving to be good hosts for *K. lacca* during the summer crop, 2016. Comparison was

made between *K. lacca* (*rangeeni* and *kusmi*) which revealed that, *K. lacca rangeeni* performed well with all biological parameter compared to *K. lacca* (*kusmi*). Higher density of settlement (89.6 and 75.5 per sq cm) with lesser initial mortality (19.11 and 36.8 per cent), more fecundity (297 and 89), cell weight (12.3 and 9.4 mg) & resin weight (9.8 and 7.7 mg), broodlac weight (2.05 and 0.8 kg per plant) and broodlac ratio (3.6 and 2.3) on *K. lacca* (*rangeeni*) and *K. lacca* (*kusmi*) were recorded, respectively.

National Lac insect Germplasm Center

Conservation of Lac insects/Host plants Biodiversity

Ninety collections of 29 genera and 55 species are being conserved in the Lac Host Field Gene Bank.

Swadi palas plantations consisting of 75 plants are being conserved in a separate plot.

A total of 1825 cultures of 73 lac insect lines are being conserved on potted plants of *F. macrophylla*.

1.2 Identification and cloning of putative key genes involved in terpene biosynthesis of the Indian lac insect, *Kerria lacca* (Kerr)

Prenyl transeferases play a key role in the biosynthesis of terpenic acids. The prenyl transeferase cDNA of around 1 Kb (Fig. 9) was cloned by using gene specific primers available from transcriptome data. The cloned gene was sequenced and blast analysis was done to identify the cloned gene. It was found to match with DPDS (decaprenyl diphosphate synthase) of other insects. Phylogenetic tree revealed that the cloned gene was closely related to *Acyrthosiphon pisum, Aphis gossypii and Rhopalosiphum padi* DPDS gene. The expression of DPDS in different developmental stages of lac insects was studied by performing quantitative PCR. Higher expression of the cloned DPDS was observed in settled larvae stage as compared to crawlers and female lac insects.

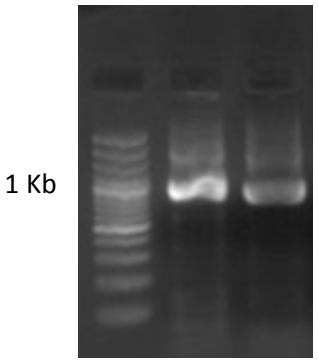


Fig. 9: Cloning of partial DPDS gene from *Kerria lacca*

One SSH library using crawler cDNA as driver and female lac insect cDNA as tester was constructed. The sequencing of the library revealed the presence of genes belonging to different categories include lipid metabolism, amino acid metabolism, hormone biosynthesis, maturation, respiration, protein synthesis, cell growth and differentiation, carbon metabolism, intracellular trafficking and few hypothetical genes for which functions are not known.

1.3 Development and evaluation of lac production technologies

Pruning response in *swadi palas* at farmers' field over years

To establish the pruning schedule of *swadi palas* ten trees each in December, January, February and March were pruned for two consecutive years and data on length and diameter of new shoots were recorded before *kusmi* lac insect inoculation in July. The length of new shoot was significantly better in January pruning and it was at par to February pruning (Fig. 10). Although, variation in thickness of new shoot was non significant but new shoot appeared in March pruning was very thin. The winter *kusmi* broodlac output ratio was significantly higher in January pruning and it was at par to February pruning. Broodlac yield was badly affected in December and March pruning. Therefore, it is not advisable to prun *swadi palas* in December and March.

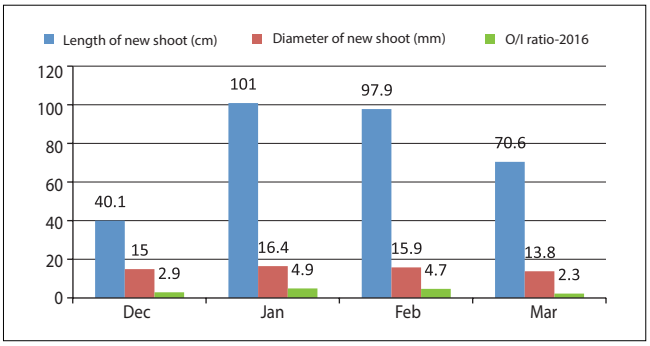


Fig.10: Shoot growth and lac yield in *swadi palas* over year

Pigeon pea germplasm for summer *rangeeni* crop, 2016

Lac yield in different pigeon pea germplasms were represented in descending order by bars, and the cumulative total represented by the line through a pareto chart. The left vertical axis is the frequency of occurrence, but it can alternatively represent another important unit of measure. It was prepared with lac and grain attributing traits. Germplasm RCMP 4, ICPR

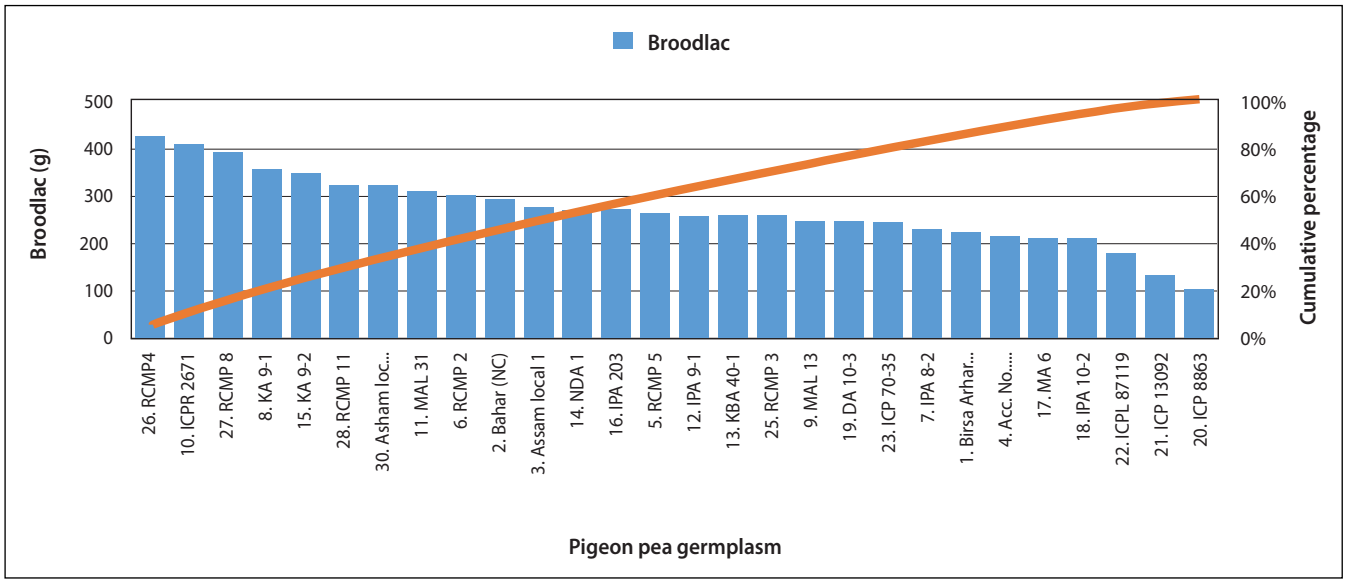


Fig. 11: Pareto chart plots of broodlac production on pigeon pea

2671, RCMP 8, KA 9-1, KA 9-2, RCMP 11, Assam local 2, MAL 31 and RCMP 2 had more than 60 per cent contribution towards broodlac (Fig. 11).

Development of SSR marker for identification of high *rangeeni* lac yielding germplasm of pigeon pea

Genomic DNA isolation from pigeon pea has been standardized using CTAB method (Fig.12). The standardized protocol was employed to isolate genomic DNA from 27 varieties of pigeon pea (Birsa Arhar 1, Birsa Arhar 2, Bahar, Assam Local 1, Assam Local 2, Assam Local 3, Acc No.- 591139, RCMP 2, RCMP 3, RCMP 4, RCMP 5, S-RCMP 5, RCMP 8, RCMP 11, IPA 8-2, S-IPA 8-2, IPA 9-1, KA 9-2, MA 6, MA 13, MA 31, KBA 40-1, NDA 1, ICPR 2671, ICPL 87119, ICP 13092 and P-291). The PCR conditions for SSR markers have been standardized with these genomic DNA and SSR PCRs are in progress.

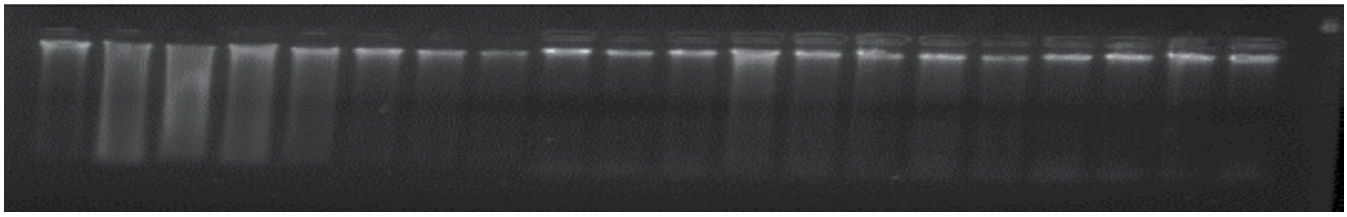


Fig. 12: Agarose gel electrophoresis of genomic DNA of different pigeon pea varieties

2. Crop Production System Management

2.1 Lac Integrated Farming System (LIFS)

Evaluation of LIFS model *semialata*+pea+mustard+ brinjal per hectare basis was done. Cost of establishment of *semialata* plantation was Rs. 12,250, while there was no lac cultivation during the first year. From the model, it was observed that the overall BC Ratio was 1.19 (as estimated for 1 ha). Based on different crop combinations, brinjal cultivation with *semialata* had BC ratio of 1.79, which proved the most remunerative during the season.

Two farmers from Gosaitoli adopted lac integrated farming system with crops like pea, cowpea, potato, lady's finger, turnip etc.

2.2 Integrated nutrient management for quick establishment of *kusum* (*Schleichera oleosa*) plantation

Germination of *kusum* seeds as affected by different time of sowing and genotypes

Germination per cent till December revealed that sowing in June-July *i.e.* during ripening is the best time for majority of genotypes. Values ranged between 20-40 per cent in June sowing. Some genotypes did not germinate in July sowing due to delayed sowing (7 days). However, in another study, the composite collection which was sown within 2 days of collection, germinated 60 per cent. The genotype giving the highest germination per cent was found to be located in open space receiving abundant sunshine and it

was not pruned since last 4 years. May pruning also performed satisfactory for the same genotype. It indicated that unpruned and well exposed trees are good for giving seeds of satisfactory germination per cent even when seeds are collected one month before maturity (Fig. 13 to 15).

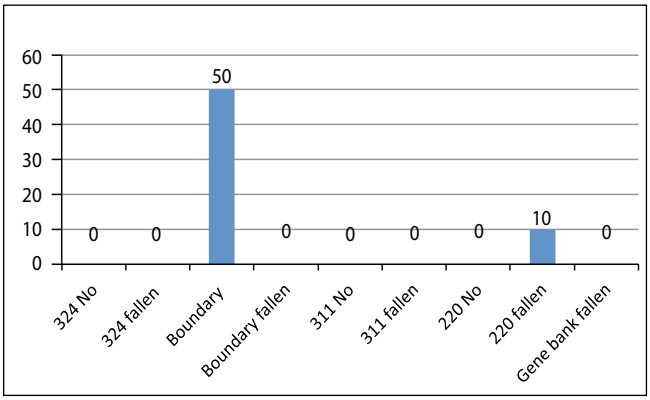


Fig. 13: Germination per cent as affected by different genotypes in May sowing

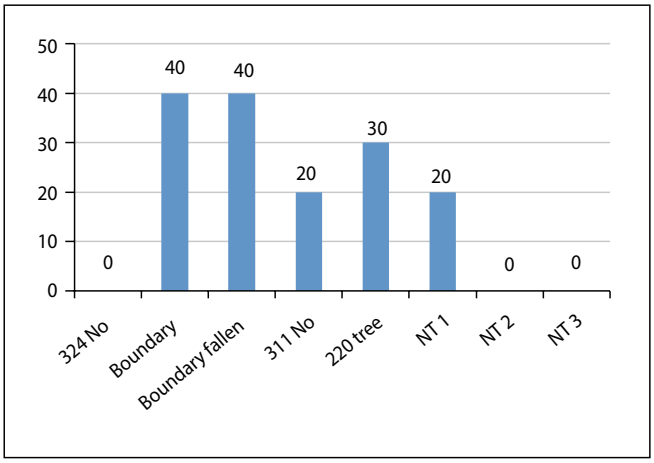


Fig. 14: Germination per cent as affected by different genotypes in June sowing

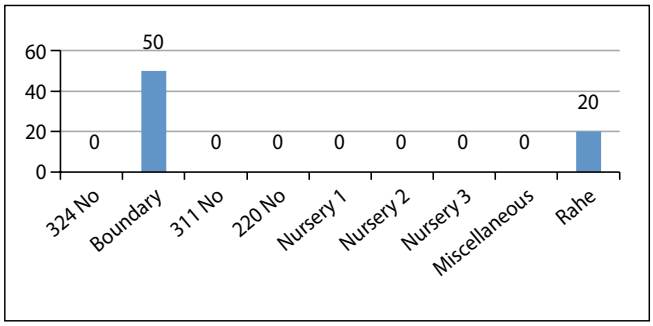


Fig. 15: Germination per cent as affected by different genotypes in July sowing

Study also depicted that number of fallen fruits decreased significantly after June. Fallen seeds collected from unpruned trees with exposure to sunshine (boundary located tree) also showed equal response in germination in June sowing. May sowing of seeds collected from fallen fruits came up with very negligible performance of germination. Lesser fruit weight could be the reason behind it (Fig. 16). Thus well exposed and unpruned trees are superior in producing quality seeds and at the same time it gives flexibility in collection time (from May end to July) and type of collection (fallen fruit or tree plucking)

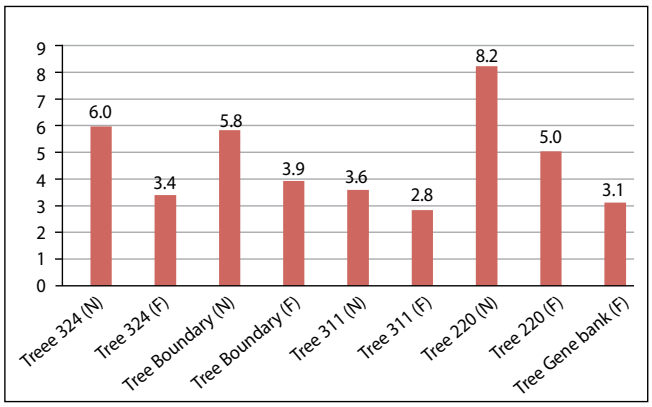


Fig. 16: Fresh wt (g) of normal tree plucking (N) and fallen fruits (F) of *kusum* genotypes

Effect of composition of soil media on germination per cent and seedling mortality

Two types of soil mixture were prepared *i.e.* with i) 33% FYM and ii) 33% FYM + 25 g lime/ polybag. No significant difference in germination per cent was obtained. But seedling mortality was significantly lower in lime application (50% lower) compared to only FYM application (Fig. 17 &18).

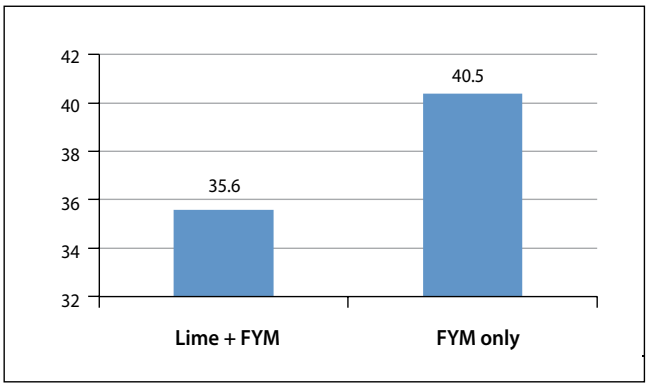


Fig. 17: Germination per cent in different soil media

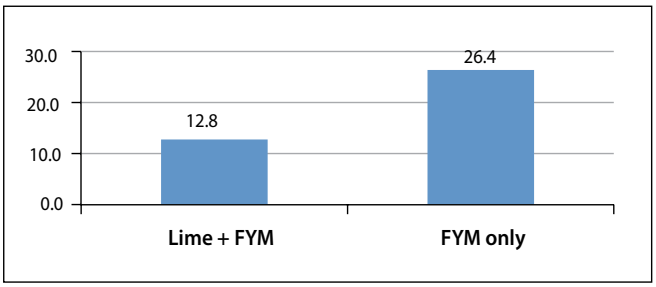


Fig. 18: Seedling mortality per cent in different soil media

Effect of seed germination and seedling growth affected by genotypes and PGPR inoculation

Total eight genotypes of *kusum* seeds were inoculated with azotobacter, phosphobacterin and VAM. By mid July; highest germination per cent (37%) was observed under Nursery Tree No 1 and lowest (18.8%) was observed on Miscellaneous/ mixed collection. Least germination per cent obtained from mixed collection. Since, it is an admixture of several genotypes and collected from fallen fruits, quality was not uniform.

Inoculation of Azotobacter (A) and VAM (V) individually raised the germination per cent to 34.7 from 21.6 and 36.9 from 19.4 per cent, respectively. However, Phosphobacterin inoculation proved to reduce germination to 19.4 per cent against its control 36.9 per cent (Table 1).

Table 1. Factors affecting seed germination and seedling growth as affected by genotypes and PGPR inoculation

Genotypes with different factors	Germination Per cent	Height (cm)	No. of leaves	Leaf length (cm)
Tree no. 324	35.0	5.8	3.0	5.5
Boundary Tree	27.5	4.9	2.8	4.2
Tree no. 311	21.3	5.0	2.7	4.5
Nursery Tree No. 1	37.5	7.2	3.6	6.2
Nursery Tree No. 2	23.8	4.8	2.0	3.8
Nursery Tree No. 3	30.0	6.5	3.6	5.8
Miscellaneous	18.8	3.5	2.3	3.7
Rahe Collection	31.3	5.8	2.8	4.8
CD	11.2	0.8*	0.5*	0.8*
A0	21.6	4.3	2.2	3.7
A1	34.7	6.5	3.5	5.9
CD	5.6*	0.4*	0.2*	0.4*
P0	36.9	6.4	3.4	5.6
P1	19.4	4.4	2.3	4.0
CD	5.6*	0.4*	0.2*	0.4*
V0	19.4	3.5	1.6	3.1
V1	36.9	7.4	4.1	6.5
CD	5.6*	0.4*	0.2*	0.4*

*Significant at 5% level

Study also suggested that phosphobacterin inoculation without VAM can drastically reduce germination. Two factor interaction results revealed that VAM inoculation in the absence of phosphobacterin and azotobacter inoculation in the absence of phosphobacterin gave highest germination. Values were 37.5 and 43.7%, respectively (Table 2). Seedling growth was affected in the same fashion.

Table 2. *Kusum* seed germination and plant height as affected by PGPR interaction

Phosphobacterin x VAM						Phosphobacterin x Azotobacter					
Seed germination (%)			Plant height (cm)			Seed germination (%)			Plant height (cm)		
	V0	V1		V0	V1		P0	P1		P0	P1
P0	28.13	37.50	P0	1.68	2.24	A0	21.88	17.50	A0	1.39	1.28
P1	6.88	30.00	P1	0.45	2.26	A1	43.75	19.38	A1	2.53	1.43
CD	7.27*		CD	0.55*		CD	7.27*		CD	0.55*	

*Significant at 5% level

Effect of *kusum* genotype, seed size and heat treatment on germination per cent

Kusum genotypes varied significantly in producing quality seeds for germination. Maximum germination (45%) was found on boundary located tree followed by nursery located trees, miscellaneous collection and Rahe collection (30-40%). Tree No. 311 and 324 showed the least performance (0-25%). Preliminary observation gives an idea that sunshine exposure could be the factor behind it. Boundary located tree received an exposure of 62.5% to sunshine compared to Tree No. 311 and 324 which received 10 and 20% exposure. Branch length of least exposed trees *i.e.* Tree No 311 and 324 were 2.1 and 2.55 m, respectively. The best performer tree produced maximum seed weight (13.47 g/ 10 seed). Seedling growth was also found to be highest in seeds of such tree (Table 3). Lowest values were associated with Rahe collection, seed weight of which was very low. Therefore, seed weight could be another important factor governing germination. Preliminary observation suggested that trees having lesser germination per cent (tree No. 324) are associated with marginal difference in seed dry/ fresh weight ratio in fallen and normal seeds (Fig. 19) and *vice versa* (boundary and tree No. 311).

Table 3. Germination per cent and seedling growth of *kusum* as affected by genotypes, seed size and heat treatment

Genotypes	Germination per cent	Height	Number of leaves	Leaflet length
Tree no. 324	0.0	0.0	0.0	0.0
Boundary located	45.0	4.9	2.7	3.6
Tree no. 311	25.0	1.5	0.3	0.8
Nursery Tree No.1	35.0	2.9	1.3	2.5
Nursery Tree No. 2	40.0	3.3	1.3	1.9
Nursery Tree No. 3	30.0	1.1	0.8	1.2
Miscellaneous	35.0	1.3	1.1	1.1
Rahe	30.0	1.5	0.9	0.6
CD	21.9*	1.7*	1.1*	1.3*
Small seed	13.8	0.8	0.6	0.5
Big seed	46.3	3.3	1.5	2.4
CD	11.0*	0.8*	0.6*	0.6*
No heat	30.0	1.4	0.9	1.0
Heat	30.0	2.8	1.3	1.9
CD	11.0	0.8*	0.6	0.6*

*Significant at 5% level

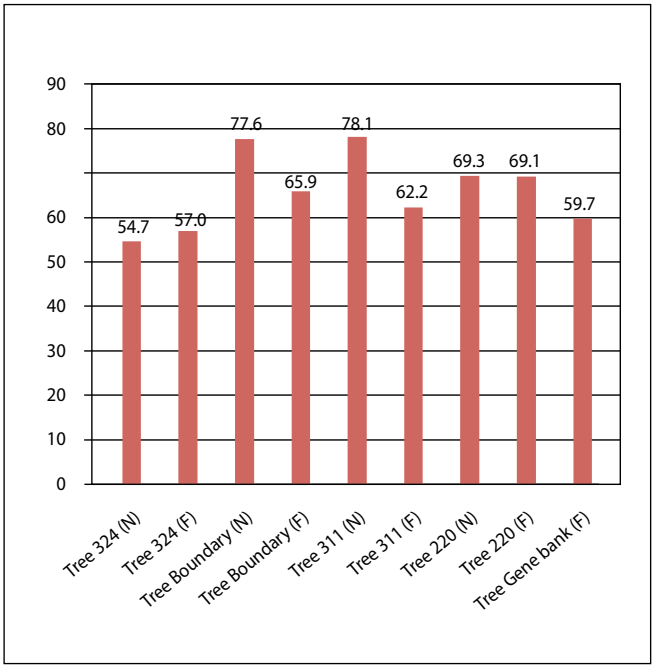


Fig. 19: Seed dry/ fresh wt ratio (%) of normal and fallen seeds of *kusum* genotypes

Seed size is yet another factor which dictates seed germination. Big sized seeds germinated 46% compared to 14% small sized seeds. Growth of seedlings was found to be significantly higher in bigger seeds. Heat treatment did not prove to play important role but seedling growth was satisfactory compared to untreated ones.

Effect of heat treatment and its duration on seed germination and seedling growth

Dry and wet seeds of *Kusum* were subjected to different temperature (30, 40 and 50 °C for different durations (3, 6 and 9 hrs). Forty degree temperature proved to be the best temperature giving 42.5% germination as against 30.8 and 8.3% in 30 and 50 °C. Seedling growth was also most satisfactory under 40 °C (Table 4).

No significant variation in germination per cent was observed due to duration in temperature. However, seedling growth was remarkably better in the treatment of 3 hour duration. Both germination and growth of seedling did not vary remarkably due to seed conditions *i.e.* dry or wet condition.

Table 4. Heat treatment, duration and seed condition affecting seed germination and seedling growth

Different conditions	Germination per cent	Height	No. of leaves	Leaflet length
Temperature				
30 °C	30.8	5.6	3.1	5.4
40 °C	42.5	6.7	3.6	5.5
50 °C	8.3	1.7	1.1	1.6
	*	*	*	*
CD	8.7	0.5	0.6	0.5
Duration				
3 hour	30.8	5.9	3.6	5.6
6 hour	27.5	4.0	2.0	3.5
9 hour	23.3	4.1	2.3	3.4
	NS	*	*	*
CD	8.7	0.5	0.6	0.5
Seed condition				
Dry seed	43.3	7.1	4.0	6.4
Wet seed	38.3	6.9	3.8	6.1
	NS	NS	NS	NS
CD	7.1	0.4	0.5	0.4

*Significant at 5% level

Effect of fertilizer application at recommended dose and field inoculation of azotobacter, phosphobacterin and VAM on growth of *kusum* seedlings

Application of fertilizer in recommended dose and phosphobacterin inoculation could influence plant growth significantly. Rate of increase in plant height due to fertilizer application was found to be two times higher as compared to no application. On the other hand, field application of phosphobacterin could check rate of reduction in chlorophyll content index significantly as compared to no inoculation (Table 5).

Table 5. Growth parameters as affected by fertilizer application and PGPR inoculation

Factors	Per cent change in values (during July to December, 2016)			
	Plant Height (cm)	Basal diameter (mm)	No. leaflet	Chlorophyll content index
F0	68.4	49.1	24.3	-58.3
F1	138.3	27.8	44.2	-55.9
A0	115.8	42.8	43.0	-65.6
A1	90.9	34.1	25.5	-48.6
P0	107.8	29.8	16.0	-75.8
P1	98.9	47.2	52.5	-38.4
V0	99.9	51.8	52.5	-61.8
V1	106.8	25.1	16.0	-52.4
CD=	32.6	16.4	42.2	13.8

*Significant at 5% level

Transfer of Technology Activity

Technology demonstration on increasing *kusmi* lac production by fertilizer application is being continued at four villages at farmers' field in the current season. Results of previous year are given below (Table 6).

Table 6. Result of the demonstration trials of recommended fertilizer application undergone at farmers' field

Sl. No.	Location/ host	Yield ratio of fertilized trees	Yield ratio of unfertilized trees	Remarks
1.	Singari village, Ranchi on *ber*	17.8	7.3	Additional some rejected lac from fertilized trees
2.	Lupungdih village, Khunti on *semialata*	11.2	7.2	Some rejected lac in both
3.	Tangerkella village, Rania on *semialata*	770 g/ plant	610 g/ plant	28 per cent higher sticklac production
4.	Mangubandh, Ranchi on *ber* big sized	10.9	3.8	–
5.	Mangubandh, Ranchi on *ber* small sized	11.1	7.4	–

Vegetative Propagation of *kusum* (*Schleichera oleosa* (Lour.) Oken)

25 cleft grafting and 25 side grafting in *kusum* were also carried out during April as well as June. Overall success in cleft grafting and side grafting was 28 and 32 per cent, respectively. Maintenance of the air layering raised seedlings and grafted seedlings were done.

2.3. Carbon sequestration under different lac host based land use systems

Estimation of above ground biomass in *semialata* plantation was done and extrapolated per hectare, with average of 3166.66 kg/ha, which corresponds to 1583.33 kg carbon per hectare. Destructive sampling was carried out for three bushes up to one meter depth and average root shoot ratio of 1.40 by weight was noted; resultant from deep tap root system with multiple laterals. This corresponds to average root biomass of 5559 kg/ha, equivalent to 2229.6 kg carbon per hectare. Estimation of carbon stocks under LIFS is under progress. LIFS plot taken for the study constitutes of 9 lines of *semialata*, 3 lines of guava (26 trees), 20 *ber* trees in 5 lines mixed with 25 plants of *aonla* and 2 lines of lemon in 50m × 50m plot. Biometric data for the above ground biomass for the different components was taken for the year for estimation of carbon stock. Under *semialata*, above ground biomass was 91.8 kg, corresponding to root biomass of 128.52 kg; this accounts for total of 110.16 kg carbon from stem and root biomass of *semialata*. Under *ber*, above ground biomass estimated from allometric equation was 17551 kg for the given trees, corresponding to 8775.8 kg carbon. Root biomass estimated was 4182.5 kg, equivalent to 2091 kg carbon.

2.4. Tritrophic interaction in lac ecosystem

Tritrophic interaction in lac ecosystem: A semiochemical approach

Comparative analysis of semiochemicals from lac insect ecosystem using GC-MS

The study was conducted with an aim of detecting specific semiochemicals in lac insect ecosystem which might be of use in pest management in lac production system. Volatiles collected by extraction with hexane from nine different samples such as leaves of inoculated and un-inoculated host plant (*Flemingia semialata*), lac insect (crawler, male, female during sexual maturity and adult female), whole lac insect body (lac insect with resin and wax), lac

resin and wax, were detected using GC-MS. Volatiles obtained, depending on the relative content, were classified arbitrarily in to major (>0.5%) and minor compounds (<0.5%). The details of comparative profiling of volatiles are given below:

a. Volatiles from leaves of host plant

Volatiles from host plant *F. semialata* were collected both under lac inoculated (T_1) and lac un-inoculated (T_2) condition. Comparative analysis detected 52 volatiles out of which 22 were designated as major compounds. Among the major compounds, only Tetradecane and Pentadecane were commonly present under both treatments. Out of the 20 other major compounds, six were specific to un-inoculated leaves while 14 were specific to inoculated leaves. Decane, dodecane, hexadecane and nonadecane were detected only in T_1 and constituted 90.6% of the total volatiles (Fig. 20). Among the 30 minor compounds detected, Disulfide dioctyl, 2,3-Heptanedione and Pentane, 2,2,4-trimethyl were specific to T_2 while 27 compounds were detected as specific to T_1. This indicates that inoculation of lac initialize the trigger for release of plethora of volatiles from the host plant, the role of which is to be studied in detail.

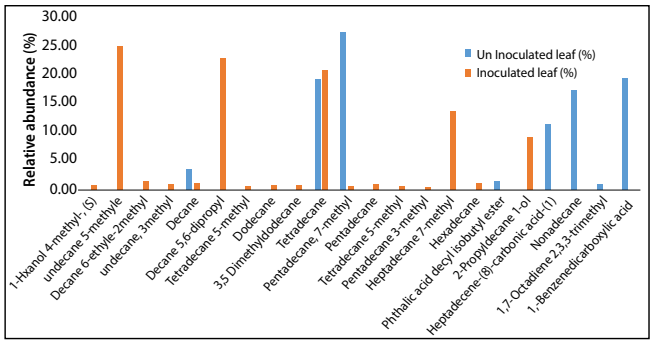


Fig. 20: Relative abundance of major volatile compounds in leaves of lac inoculated and lac un-inoculated *F. semialata*

b. Volatiles from different life stage of lac insect

The comparative profiling of volatiles from male (T_3) and female lac insect (T_4) were carried out to detect the influence of sex on the nature of volatile released. A total of 67 volatiles were detected out of which 36 were designated as major compound. Five major compounds *viz*., Heptane 3,4-Dimethyl, Pentadecane, Tetradecanoic acid, 9-Octadecenoic acid, 1-Heptacosanol were specific to female while four major compounds *viz*., butyl undecyl ester of Phthalic acid and Cyclooctasiloxane derivatives of hexadecamethyl, octadecamethyl and tetracosamethyl were specific to male. Seven major compounds *viz*., Decane, Dodecane, Tetradecane, Heptadecane, Eicosane, Tetracontane and Octacosyl acetate constituted 77% and 78% respectively in male and female lac insect. Out of 31 minor compounds detected, 12 were specific to male, 4 compounds were specific to female and 15 compounds were common to both male and female lac insect (Fig. 21).

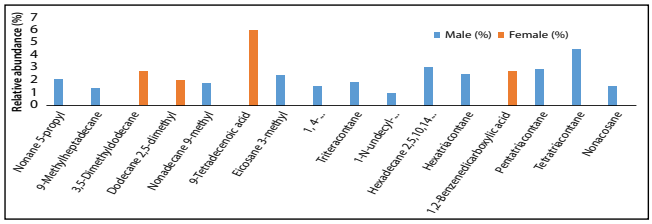


Fig. 21: Relative abundance of minor volatile compounds specific to either male or female lac insect

The comparative profiling of volatiles from crawler (T_5) and adult female lac insect (T_6) were carried out to check the temporal difference in volatile profile in lac insect. A total of 78 volatiles were detected out of which 24 were designated as major compound. There was no major compound specific either to crawler or to adult female lac insect. Five major compounds *viz*., Decane, Dodecane, Tetradecane, Heptadecane and Eicosane, constituted 79% and 83% in crawler and adult female lac insect, respectively. Out of the 54 minor compounds detected, 21 compounds were specific to crawler, 15 compounds were specific to adult female lac insect (Fig. 22) and 18 compounds were common to both the samples.

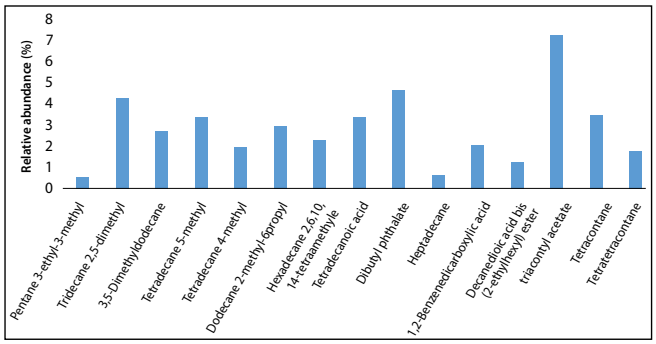


Fig. 22: Relative abundance of minor volatile compounds specific to adult female lac insect in comparison to crawler

c. Volatiles from lac insect and associated products

The comparative profiling of volatiles from lac insect and its associated products *viz*., lac resin and wax were carried out to detect the specific volatiles from each component separately. Three samples *viz*., whole lac insect body (lac insect with resin and wax, T_7), lac resin (T_8) and lac wax (T_9) were analysed for this purpose. A total of 59 volatiles were detected out of which 28 were designated as major

compound. Four compounds *viz*., Tetratetracotane, 9-Octadecenamide, Octadecanal and 1-Heptacosanol was absent in lac wax in comparison to that of lac resin. Six major compounds *viz*., Decane, Dodecane, Tetradecane, Heptadecane, Eicosane and Octacosyl acetate constituted 78%, 79% and 85% in whole lac insect body, lac resin and lac wax, respectively (Fig. 23).

As a whole, volatiles like Decane, Dodecane, Hexadecane and Nonadecane which were present specifically in leaves of lac inoculated plants were also detected in adult female lac insect. It can be inferred that these compounds might be specifically induced by lac insect in host plants for its chemical communication with its associated fauna.

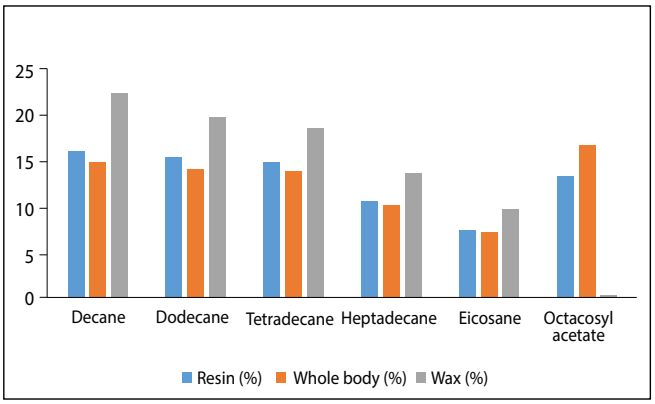


Fig. 23: Relative abundance of six major volatile compounds in lac insect and associated products

Effort was made to fabricate Y tube and four arms of Olfactometer using acrylic sheet for behavioural studies of predator/prasitoids populations with the extracted volatiles from lac insect and associated products. Studies were tried with predator/prasitoids populations but did not perform well.

Abundance of lac associated fauna using aerial insect trap

Aerial insect trap was used to study the abundance of aerial insects of lac associated fauna in IRF. Results indicated that, abundance of lac associated fauna *viz*., *T. tachardiae* (7 Nos.), *Eublemma amabillis* (3 Nos.) and *Bracon greeni* (1 No) from *kusmi* lac on *ber* field and *A. purpureus* (1 No), *T. tachardiae* (8 Nos.), *E. amabillis* (5 Nos.), *P. pulverea* (3 Nos.), *B. greeni* (2 Nos.) and *Pritomerus sulci* (1 No) from *kusmi* lac on *semialata* field were recorded in very less numbers during whole crop period. Study suggested that aerial insect trap is not suitable for recording lac associated fauna in the lac crops (Fig. 24).

Fig. 24: Aerial insect trap in the field of winter *kusmi* lac on *semialata*

2.5 Effect of abiotic factors on lac associated fauna in rangeeni crops

Relative abundance of lac associated fauna during *rangeeni* lac crops

Relative abundance and emergence profile of parasitoids and predators associated with lac insect were recorded at Institute Research Farm, ICAR-IINRG during *baisakhi* (2016) and *katki* (2016) crops under two different conditions *viz*., Fipronil + Chlorothalonil and Chlorothalonil only. The information generated reveals that, only three parasitoids (*A. purpureus, T. tachardiae* and *P. clavicornis*) were abundant in *baisakhi* 2016 whereas in *katki*, 2016 *Eublemma amabilis* was also abundant in addition to three parasitoids. Lac associated fauna was recorded upto 21 week after inoculation (WAI). But, complete mortality of lac insect was observed after 21 WAI on *ber* during *baisakhi* (2016), whereas in *katki*, 2016 lac associated fauna was recorded upto crop maturity period. Population of lac associated fauna was recorded more on sprayed with Chlorothalonil only (17.33 and 77.67 nos per meter lac encrustation) compared to Fipronil + Chlorothalonil (6.67 and 17.99 nos per meter lac encrustation) during *baisakhi* and *katki,* 2016, respectively. Among lac associated fauna, *A. purpureus* was recorded more numbers sprayed with Chlorothalonil only (15.67 and 55.33 nos per meter lac encrustation) compared to Fipronil + Chlorothalonil (4.00 and 8.66 nos per meter lac encrustation) during *baisakhi* and *katki*, 2016, respectively. Abundance of lac associated fauna was more in *ber* (95.66 nos per meter lac encrustation) as compared to *palas* (54.67 nos per meter lac encrustation) in which *A. purpureus* was more on *ber* (63.99 nos per meter lac encrustation) whereas *T. tachardiae* (23.33 nos per meter lac encrustation) and *E. amabilis* (17.33 nos per meter lac encrustation) were more on *palas* during *katki*, 2016.

Emergence profile of lac associated fauna during *rangeeni* lac crops

Study on weekly emergence profile of lac associated fauna showed maximum population of *A. purpureus* in those samples which were collected 19 WAI during sexual maturity period on *ber* 4 and 16 in Fipronil + Chlorothalonil and Chlorothalonil only respectively when caged during *baisakhi* 2016 (Figs. 25 & 26), whereas, in *katki* 2016, the maximum emergence of *T. tachardiae* (2 and 6) and *A. purpureus* (3 and 12) was recorded during 12 WAI (crop maturity period) when raised on *ber* in Fipronil + Chlorothalonil and Chlorothalonil only respectively. However in *palas*, *E. amabilis* (2 and 7) was recorded more in Fipronil + Chlorothalonil on 13 WAI and Chlorothalonil only on 12 WAI, respectively (Fig. 27 to 30).

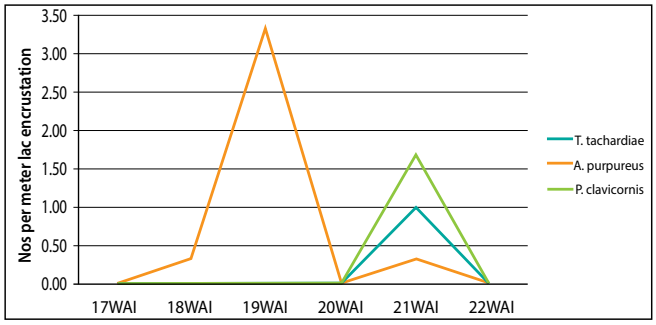


Fig. 25: Emergence profile of lac associated fauna on *ber* during *baisakhi* 2016 (Fipronil+ Chlorothalonil)

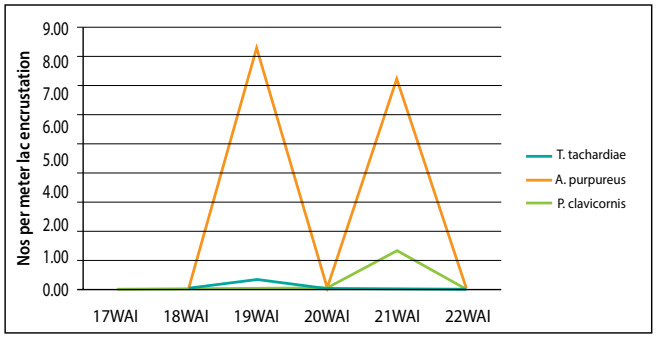


Fig. 26: Emergence profile of lac associated fauna on *ber* during *baisakhi* 2016 (Chlorothalonil only)

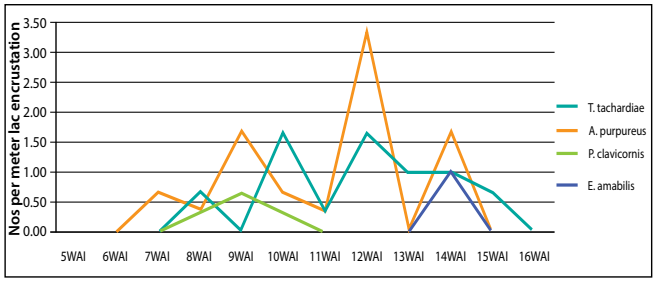


Fig. 27: Emergence profile of lac associated fauna on *ber* during *katki* 2016 (Fipronil+ Chlorothalonil)

Fig. 28: Emergence profile of lac associated fauna on *ber* during *katki* 2016 (Chlorothalonil only)

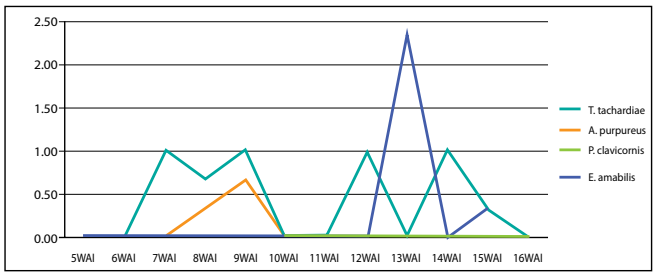


Fig. 29: Emergence profile of lac associated fauna on *palas* during *katki* 2016 (Fipronil+ Chlorothalonil)

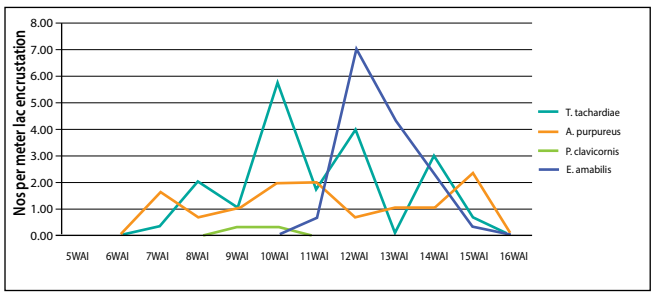


Fig. 30: Emergence profile of lac associated fauna on *palas* during *katki* 2016 (Chlorothalonil only)

In addition, emergence profile of lac associated fauna was compared between different caging methods *viz.*, *in-situ* caging and lab caging during *baisakhi* 2016 and *katki*, 2016. Higher number of parasitoids was recorded in *in-situ* method of caging compared to lab caging. *A. purpureus*, *P. clavicornis* and *E. amabilis* were more in number when sprayed with Chlorothalonil only whereas *T. tachardiae* more in sprayed with Fipronil + Chlorothalonil in *in-situ* method of caging during *baisakhi* 2016 (Fig. 31). Fipronil spray may be effective against *A. purpureus*, *P. clavicornis* and *E. amabilis* but less effective against *T. tachardiae*. Similar trend was observed during *katki*, 2016 (Fig. 32 & 33). Interestingly, *E. amabilis* (adult) was recorded in very less numbers upto 30 days of caging after that lac encrustation sample was pricked/scrapped in which huge number of immature stages (larva and pupa) of *E. amabilis* were recorded on both the host and methods of caging during *katki*, 2016.

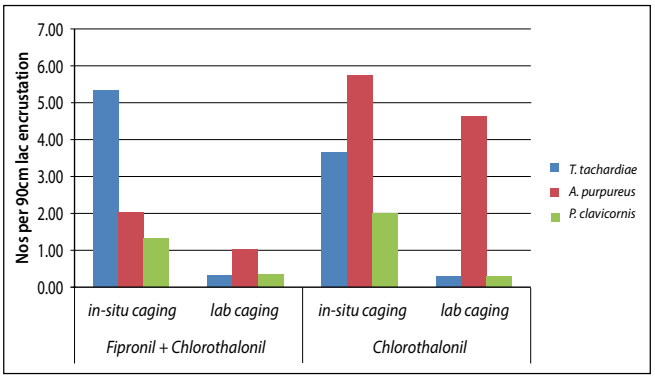


Fig. 31: Emergence profile of lac associated fauna from different methods on *ber* during *baisakhi,* 2016

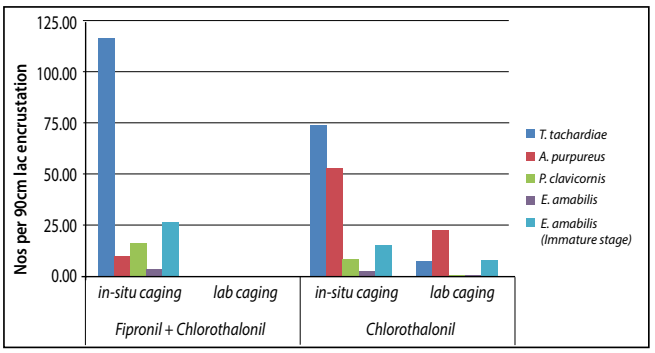


Fig. 32: Emergence profile of lac associated fauna from different methods on *ber* during *katki,* 2016

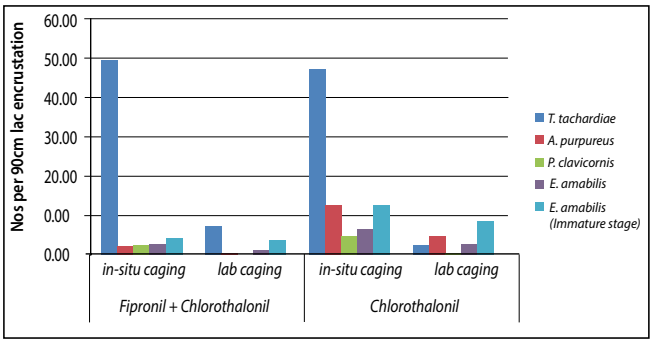


Fig. 33: Emergence profile of lac associated fauna from different methods on *palas* during *katki,* 2016

Assessment of parasitization during *rangeeni* lac crops

Lac insect cells (445 Nos.) were collected during critical period 17th to 20th week after inoculation from field during summer season *rangeeni* (*baisakhi*) crop 2016 and examined under microscope by pricking the cells to assess the level of parasitization. There were 18.4 and 61.4 per cent parasitization in live and dead lac insect cells, respectively on *ber*. Similarly, in *katki*, 2016, lac insect cells 865 and 866 were pricked on *ber* and *palas*, respectively. There were per cent parasitization in live (0.3, 1.09) and dead (4.4, 46.3) lac insect cells on *ber* and *palas*, respectively. Level of parasitization was recorded less in *katki* 2016 compared to *baisakhi* 2016 on *ber*. The maximum level of parasitization was recorded at the time of sexual maturity period on *ber* during *baisakhi* (2016) whereas in *katki* (2016), maximum level of parasitization during crop maturity period on *ber* and *palas*.

2.6 Development and validation of IPM modules for the management of predators and parasitoids associated with lac insect, *Kerria lacca* (Kerr)

Effect of Augusta™ for safety of lac insect and effect on population of insect- predators and parasitoids

Augusta™ is a new class of insecticide having active ingredient natural lactone 0.6% and natural alkaloid 0.3%. The *rangeeni* broodlac obtained from *Butea monosperma* and *kusmi* broodlac obtained from *Ziziphus mauritiana* and *Schleichera oleosa* was dipped in different formulations of this insecticide for 5, 10 and 15 minutes. There were five replications for *rangeeni* broodlac and three replications for *kusmi* broodlac with 100 g broodlac in each replicates. The randomly selected samples were dipped in the plastic bucket filled with various formulations in water. After dipping for a specified period, it was air dried and each 100 g broodlac was kept in 60 mesh net bag, separately. Thereafter, *rangeeni* broodlac was inoculated on *B. monosperma* and *kusmi* on *S. oleosa* tree as per treatment. In control, the broodlac was dipped in water only. The safety on lac insect was quantified from the lac culture sample, collected after 30 days of inoculation from *B. monosperma*. The survival per cent of lac insect in different treatments was at par with control, indicating safety of Augusta™ on lac insect. The survival per cent varied 67.5 to 67.8%, 66.25 to 76.47% and 72.29 to 75.25% against 66.7, 73.5 & 79.6% in control for 5, 10 and 15 minutes, respectively.

Effect on population of insect predators by dipping of *rangeeni* broodlac

The population of *Eublemma amabilis* reduced 94.12 to 94.74, 88.0 to 96.0 and 92.0 to 100 per cent by dipping of broodlac for 5, 10 and 15 minutes, respectively. Similarly, the population of *Pseudohypatopa pulverea* reduced to the extent of 64.7 to 88.24, 69.31 to 92.31 and 77.78 to 89.19 per cent for 5, 10 and 15 minutes, respectively. The population of insect parasitoids was low and hence conclusion for effect on parasitoid population couldn't draw (Table 7).

Table 7. Effect of *rangeeni* broodlac treatment with Augusta on population of insect predators of lac insect

Dipping time (min)	Formulation (mlL^{-1})	Lepidopteran insect predators			
		Eublemma amabilis		*Pseudohypatopa pulverea*	
		Average number*	% reduction	Average number*	% reduction
5	1.5	0.2	94.12	1.2	64.7
	2.0	0.2	94.74	0.4	88.24
	0	3.8	0	3.4	0
10	1.5	0.6	88.0	1.6	69.31
	2.0	0.2	96.0	0.4	92.31
	0	5.0	0.0	5.2	0.0
15	1.5	0.4	92.0	1.2	77.78
	2.0	0	100	0.8	89.19
	0	5	0	5.4	0.0

*Average number in 100 g broodlac

Effect on population of insect predators by dipping of *kusmi* broodlac derived from summer crop

The population of *E. amabilis* reduced 90.48 to 95.24, 100 and 100 per cent by dipping of broodlac for 5, 10 and 15 minutes, respectively. Similarly, the population of *P. pulverea* reduced to the extent of 92.59, 93.33 to 100 and 96.88 to 100 per cent for 5, 10 and 15 minutes, respectively. The population of insect parasitoids *A. purpureus* was also affected and the reduction varied 56.82 to 64.38, 59.7 to 68.66 and 67.12 to 71.23% (Table 8).

Table 8. Effect of *kusmi* broodlac treatment derived from *Schleichera oleosa* with Augusta on population of insect predators and parasitoids of lac insect.

Dipping time (min)	Formulation (mlL^{-1})	Lepidopteran insect predators				Insect parasitoids	
		Eublemma amabilis		*Pseudohypatopa pulverea*		*Aprostocetus purpureus*	
		Average number*	% reduction	Average number*	% reduction	Average number*	% reduction
5	1.5	0.67	90.48	0.67	92.59	12.67	56.82
	2.0	0.33	95.24	0.67	92.59	8.67	64.38
	0	7.0	0	9.0	0	29.33	0
10	1.5	0.0	100	0.33	93.33	9.0	59.7
	2.0	0.0	100	0.0	100	7.0	68.66
	0	3.0	0	5.0	0	22.33	0
15	1.5	0.0	100	0.33	96.88	8.0	67.12
	2.0	0.0	100	0.33	100	7.0	71.23
	0	5.33	0	10.67	0	24.33	0

*Average number in 100 g broodlac

Effect on population of insect predators by dipping of *kusmi* broodlac derived from winter crop

The population of *E. amabilis* reduced 90.91 to 100, 96.15 to 100 and 96.43 to 100 per cent by dipping of broodlac for 5, 10 and 15 minutes, respectively. Similarly the population of *P. pulverea* reduced to the extent of 54.55 to 81.82, 66.67 to 100 and 75.00 to 100 per cent for 5, 10 and 15 minutes, respectively. The population of insect parasitoids were low and hence the analysis was not undertaken (Table 9).

Table 9. Effect of *kusmi* broodlac treatment from *Ziziphus mauritiana* with Augusta on population of insect predators of lac insect

Dipping time (min)	Formulation (mlL-1)	Insect predators			
		Eublemma amabilis		*Pseudohypatopa pulverea*	
		Average number*	% reduction	Average number*	% reduction
5	0.5	0.33	90.91	1.67	54.55
	1.0	0.33	90.91	1.33	63.64
	1.5	0.33	90.91	1.0	72.73
	2.0	0.0	100	0.67	81.82
	0	3.67	0	3.67	0.0
10	0.5	0.33	96.15	0.67	66.67
	1.0	0.0	100	0.67	66.67
	1.5	0.0	100	0.00	100
	2.0	0.0	100	0.0	100
	0	8.67	0	2.0	0
15	0.5	0.33	96.43	0.67	75.0
	1.0	0.33	96.43	0.67	75.0
	1.5	0.0	100	0.0	100
	2.0	0.0	100	0.0	100
	0	9.33	0	2.67	0.0

*Average number in 100 g broodlac

2.7 Evaluation of lac mud as organic manure

Field experiments were repeated in third year to confirm the earlier finding for evaluation of lac mud as manure with spinach, tomato and brinjal among vegetables, and rose and chrysanthemum among floriculture.

Effect of lac mud on vegetables

Application of decomposed enriched lac mud (DELM) integrated with vermicompost and inorganic fertilizer recorded higher plant height, stem girth, number of primary branches and number of leaves per plant of brinjal and tomato at 25, 50 and 75 days after transplanting as compared to recommended practice (100% N through inorganic source). Substitution of 1/4th of recommended nitrogen through DELM, 1/4th through vermicompost and ½ through fertilizer resulted in significantly higher number of fruits per plant, fruit weight and fruit yield of brinjal and tomato, and green leaves yield of spinach (Fig. 34a to 34c). A total increase of 18.9 and 19.4 per cent in fruit yield of tomato and brinjal, respectively, and 9.37 per cent in leaf yield of spinach was recorded under 25% N through DELM + 25% N through vermicompost + 50% N through inorganic source over recommended practice.

Effect of lac mud on soil physico-chemical properties

Mean values of soil characteristics after completion of two crop sequences indicated relatively higher

content of organic carbon, available nitrogen, phosphorus and zinc in lac mud applied plots as compared to plots where only recommended source of inorganic fertilizers were applied (Table 10).

Effect of lac mud on Floriculture

Application of DELM fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O recorded higher plant height, plant spread, duration of flowering, number and weight of chrysanthemum flowers; and plant height, stalk diameter, number and weight of rose flowers (Fig. 35a & 35b). DELM fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O also initiated early flowering in rose.

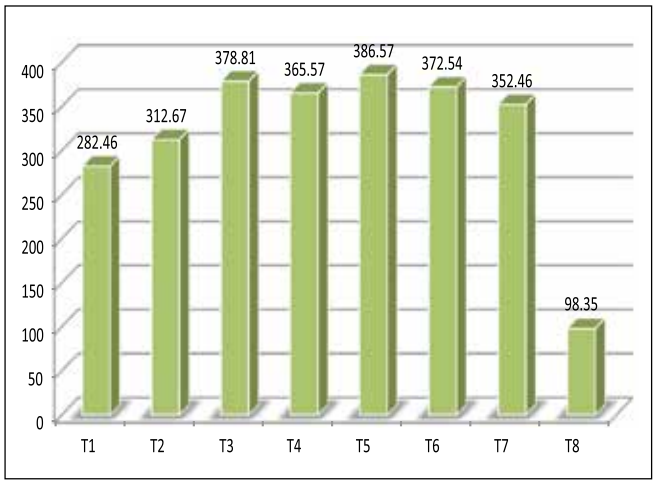


Fig. 34a: Total fresh leaf yield of spinach (q/ha)

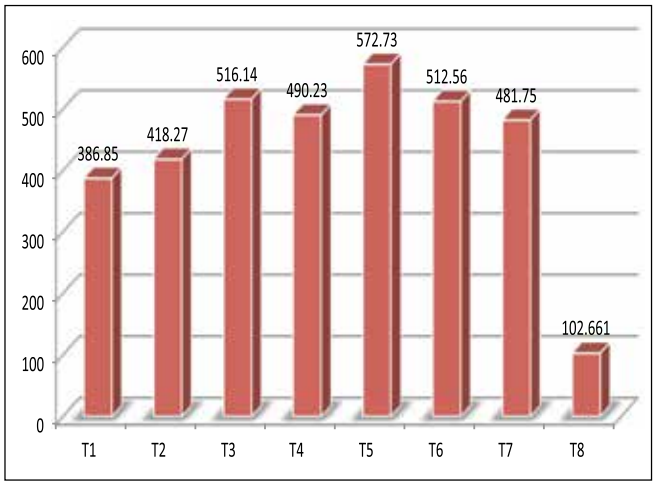


Fig. 34b: Fruit yield of tomato (q/ha)

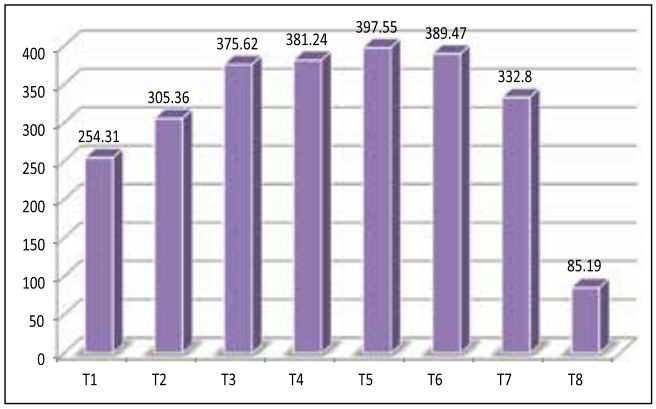


Fig. 34c: Fruit yield of brinjal (q/ha)

Table 10. Effect of lac mud based different treatment on soil physico-chemical properties after two crop sequences of vegetables

Treatment	pH	EC (dSm^{-1})	OC (%)	Available Nitrogen ($kg\ ha^{-1}$)	Available Phosphorus ($kg\ ha^{-1}$)	Available Potash ($kg\ ha^{-1}$)	Zinc ($mgkg^{-1}$)	Water Holding Capacity (%)	Bulk density (g/cm^3)
T_1 - 100% N through DELM	4.82	0.086	0.77	370.5	58.55	287.47	2.164	37.82	1.39
T_2 - 75% N through DELM+ 25% N through inorganic source	4.73	0.074	0.75	366.8	56.25	280.35	2.107	36.15	1.40
T_3 - 50% N through DELM+ 50% N through inorganic source	4.68	0.070	0.72	353.2	54.53	268.78	2.023	32.39	1.42
T_4 - 25% N through DELM+ 75% N through inorganic source	4.65	0.065	0.68	332.4	51.31	253.65	1.911	33.63	1.42

Treatment	pH	EC (dSm^{-1})	OC (%)	Available Nitrogen ($kg\ ha^{-1}$)	Available Phosphorus ($kg\ ha^{-1}$)	Available Potash ($kg\ ha^{-1}$)	Zinc ($mgkg^{-1}$)	Water Holding Capacity (%)	Bulk density (g/cm^3)
T_5- 25% N through DELM+ 25% N through vermi-compost + 50% N through inorganic source	4.70	0.068	0.74	364.7	56.91	276.79	2.079	36.15	1.40
T_6- 12.5% N through DELM+ 12.5% N through vermi-compost + 75% N through inorganic source	4.66	0.062	0.70	341.2	53.31	261.66	1.967	34.04	1.42
T_7- 100% N through inorganic source	4.40	0.058	0.60	291.9	49.70	245.34	1.572	30.80	1.45
T_8- Control (No manure and fertilizers)	4.61	0.056	0.60	291.9	48.92	237.77	1.427	31.76	1.43

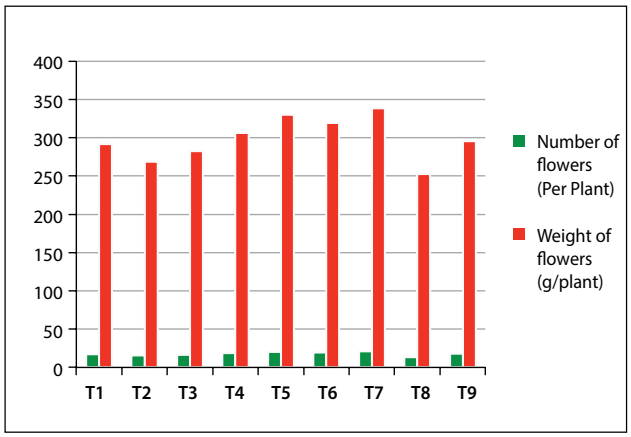


Fig. 35a: Number and weight of *chrysanthemum* flower

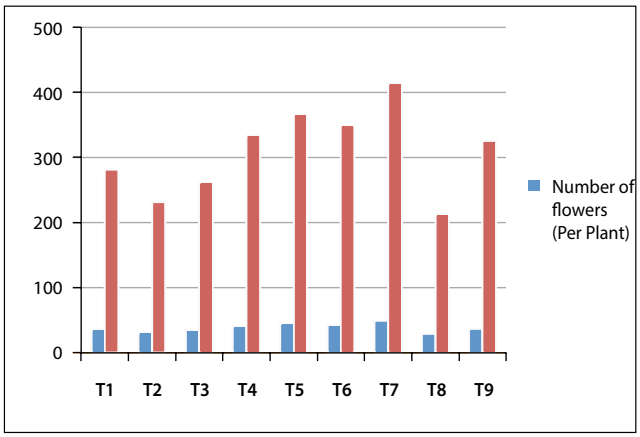


Fig. 35b: Number and weight of rose flower

Treatments: T_1-DELM (fortified with 0.2% N), T_2-DELM (fortified with 0.2% P_2O_5), T_3-DELM (fortified with 0.2% K_2O), T_4- DELM (fortified with 0.2% N + 0.2% P_2O_5), T_5-DELM (fortified with 0.2% N + 0.2% K_2O), T_6-DELM (fortified with 0.2% P_2O_5 + 0.2% K_2O), T_7- DELM (fortified with 0.2% N + 0.2% P2O5 + 0.2% K_2O), T_8-Lac mud (without fortification and biofertilizer), T_9-Vermicompost.

2.8 Package of practices for *rangeeni* lac cultivation on *Flemingia semialata*

Baisakhi crop on *F. semialata* survived up to the month of May and after that crop mortality was noticed. *Katki* crop gave satisfactory performance. *Baisakhi* crop raised as inoculated and self inoculated after *katki* crop is in progress. *Semialata* plants were pruned at different durations to study the effect on growth.

Performance of *baisakhi ari* and *katki* crops

Baisakhi ari and *katki* crops showed better performance under under irrigation + mulching compared to irrigation and no-irrigation treatments (Table 11). This practice yielded higher weight of lac stick (101 g/m and 105 g/bush) in *baisakhi ari* crop and broodlac (97 g/m and 98 g/bush) in *katki* crop on stick length and bush basis as well as higher scrap and 10-single cell in both the crops.

Table 11. Weight of lac stick, scrap, 10-single cell and height and number of shoots of *baisakhi ari* and *katki* crop on *F. semialata* at harvest

Treatment		Weight of lac stick/ broodlac yield		Fresh scrap weight (g/m)	10-single cell weight (g)	Shoot height (cm)	No. of shoots/ bush
		(g/m of stick)	(gram /bush)				
Baisakhi ari	No Irrigation	57.70	62.68	2.6 75	0.106	111.85	5.8
	Irrigation	91.90	97.52	5.648	0.181	134.96	8.7
	Irrigation + Mulching	101.03	105.48	6.457	0.217	157.48	10.4
***Katki* crop**	No Irrigation	87.64	88.98	7.7	0.123	124.61	12.06
	Irrigation	91.98	93.34	8.3	0.130	141.42	15.38
	Irrigation + Mulching	97.34	97.64	9.0	0.137	147.54	16.76

Effect of agronomic management practices on shoot height and number of bushes

Relatively more shoot height and higher number of shoots in a bush was recorded under irrigation along with mulching with dry grasses over different dates of pruning at monthly intervals (Fig. 36a to 36f). It was followed by irrigation and least was recorded under no-irrigation.

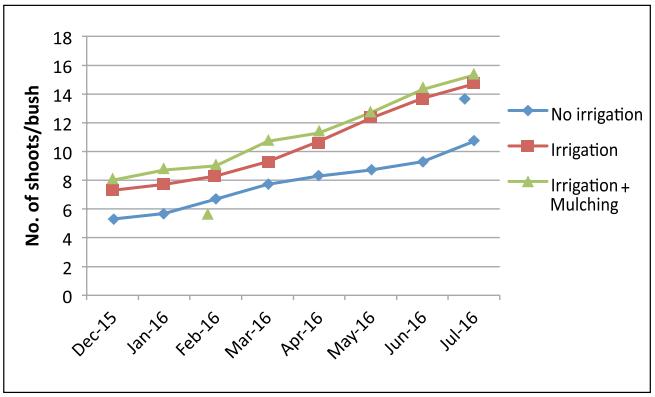


Fig. 36a: Shoot height of *F. semialata* pruned in May 2015

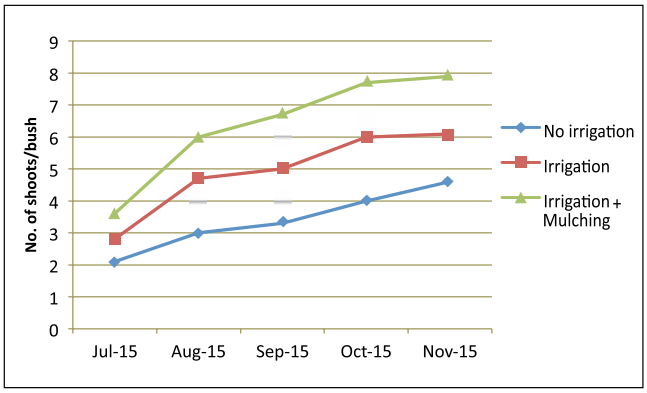


Fig. 36b: No. of shoots in *F. semialata* pruned in May 2015

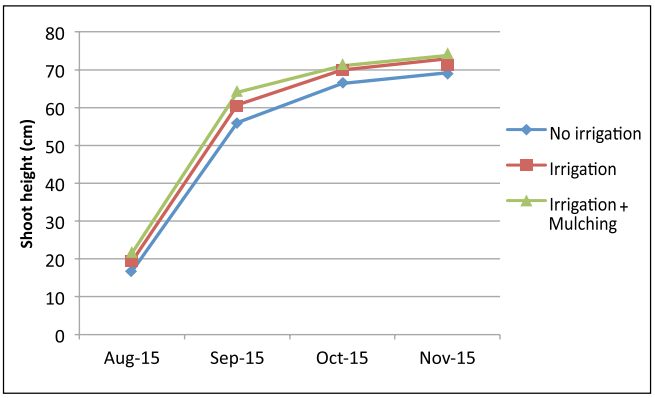


Fig. 36c: Shoot height of *F. semialata* pruned in July 2015

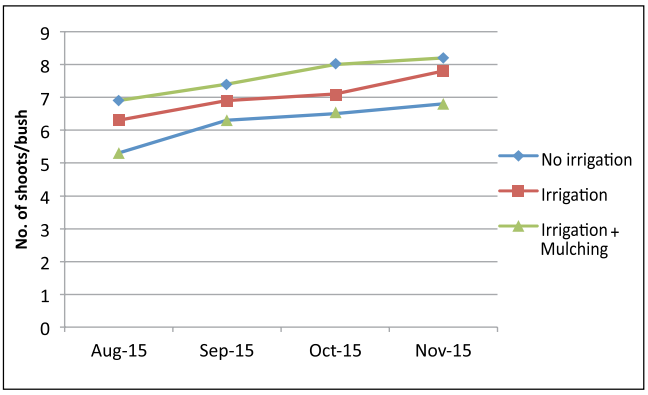


Fig. 36d: No. of shoots in *F. semialata* pruned in July 2015

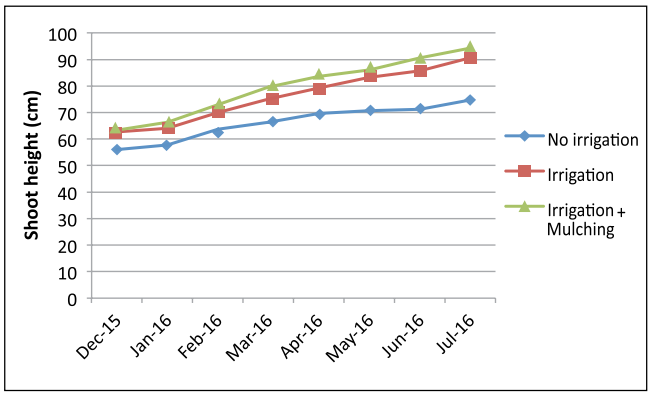


Fig. 36e: Shoot height of *F. semialata* pruned in November 2015

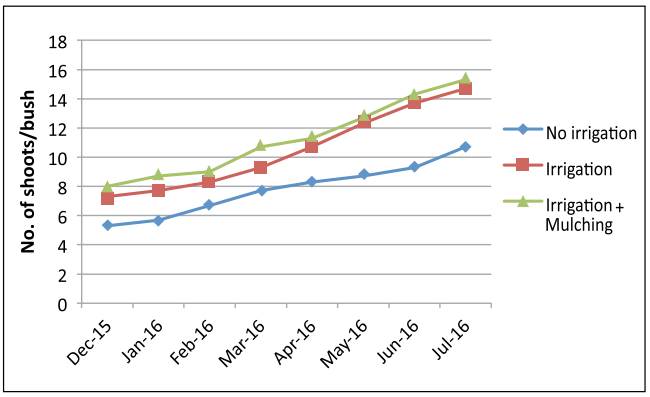


Fig. 36f: No. of shoots in *F. semialata* pruned in November 2015

2.9 Exploratory studies

Raising of new plantation of willow clones

Dr. SS Bhat raised new plantation of willow clones, procured from Dr. YSP UHF, Solan. Sixteen clones with 4 seedlings of each have been planted in the IRF, ICAR -IINRG. Since the willow is a temperate species, some clones did not survive due to harsh summer of the year, but some clones are performing well.

Improvement in isolation protocol of aleuritic acid study

The current isolation protocol of aleuritic acid results only in recovery of ~25% of actual. Also it takes 12-14 days to complete the process. To improve the yield and to reduce the time taken to complete the isolation process of aleuritic acid, Dr. Anees K has initiated an exploratory study.

Parasitoid detection in *baisakhi* crop 2016

PCR based on *Aprostocetus purpureus* specific primers were used to detect the presence of this parasitoid in *baisakhi* lac crop (2015-16) raised on *ber* trees on weekly interval. This method was able to detect the *A. purpureus* parasitization at 44 DAI (days after inoculation) in the lac crop, whereas conventional methods such as host dissection and caging detected the *A. purpureus* on 113 DAI and 112 DAI, respectively. The molecular method detected the parasitoids much earlier compared to host dissection and host rearing, which can save time and labour involved in this process.

Processing and Product Development

3. Processing, Storage and Quality Management

3.1 Design and development of Integrated Small Scale Lac Processing Unit for conversion of sticklac to seedlac

Primary lac processing operations for preparation of seedlac from sticklac is mainly done manually and requires higher input likes manpower, capital and time. Considering above points, an Integrated Small Scale Lac Processing Unit (ISSLPU) (Capacity – 100 kg/day) was designed and developed at ICAR-IINRG, Ranchi and fabricated at ICAR–CIAE, Bhopal to reduce manpower time and drudgery of the person involved in primary lac processing.

Performance evaluation of developed ISSLPU

During the process of seedlac preparation from sticklac by developed unit, it was observed that the developed unit was operated easily and efficiently. Different mechanisms provided in the unit (sticklac handling mechanism, crushing unit, grading unit, crushed sticklac handling unit, soaking unit and washing unit) were also found working as per requirement for different unit operations of seedlac preparation.

Seedlac yield, colour parameters and quality parameters of seedlac prepared by developed ISSLPU

Mean yield of seedlac prepared from sticklac by the developed ISSLPU (Fig. 37) was determined and found to be 70.84 % by weight of sticklac with mean impurity content 2.04 %. Mean yield of seedlac obtained by ISSLPU was closer to the yield of seedlac prepared by Small Scale Lac Processing Unit (SSLPU) (Fig. 38). Mean impurity content in the seedlac prepared by ISSLPU Unit was found within the standard limit as per IS: 6921 – 1973.

Fig. 37: Integrated Small Scale Lac Processing Unit

Fig. 38: Small Scale Lac Processing Unit

Mean colour parameters (*i.e.* lightness – L, redness – a, and yellowness - b) of seedlac prepared from sticklac by ISSLPU was determined using Hunter's Colorimeter (Model: LabScan XE). Mean lightness, redness and yellowness values of seedlac prepared by ISSLPU was determined as 25.51, 12.06 and 9.39, respectively whereas the values for seedlac prepared by SSLPU were 19.69, 8.44 and 5.94, respectively. Quality parameters of seedlac prepared by ISSLPU were also determined following standard methods (IS: 6921 – 1973). Mean flow, life under heat, colour index,

hot alcohol insoluble (impurity), acid value, moisture content and wax content values of prepared seedlac by ISSLPU were determined as 48.75 mm, 44.92 min, 13.83, 2.04 %, 74.04, 1.48 % and 4.21 %, respectively and the values were within the acceptable limit as per IS: 6921 – 1973.

Economic assessment

For the sake of economic assessment of the developed ISSLPU, the estimated unit cost, daily needs, machine parameters, quality parameters of seedlac, employment generation and monthly income were analyzed as detailed below:

Estimated unit cost for seedlac preparation from 100 kg sticklac by the developed ISSLPU was analyzed and determined to be Rs. 17.5 lakhs including building (working shed along with store rooms for raw material and finished products etc.), installation of machine and working capital for three months. Daily needs for seedlac preparation from 100 kg sticklac by ISSLPU *i.e.* manpower requirement for operation, requirement of sticklac, requirement of washing agent, water requirement and electricity requirement per day were worked out as 1 person, 100 kg, 0.5 kg, 1000 liter and 12 KWh, respectively on per day basis.

Under machine parameters, sticklac handling capacity of bucket elevator – 1, sticklac crushing capacity, crushing efficiency, grading capacity, grading efficiency, crushed sticklac handling capacity of bucket elevator – 2, soaking capacity, washing barrel capacity, washing time requirement and particle size of seedlac were determined as 900 kg/h, 675 kg/h, 75%, 900 kg/h, 75%, 720 kg/h, 60 kg/batch, 35 kg/batch, 2.0 – 2.5 h/batch and 8-10 mesh, respectively. The size of seedlac prepared from sticklac through the developed unit was in accordance with the specification IS: 6921 – 1973.

Analysis for employment generation and monthly income through the developed unit for preparing seedlac from 100 kg sticklac per day was also worked out. Employment generation of about 300 man-days/year can be generated through the developed unit under primary lac processing for seedlac prepared from sticklac with monthly income Rs. 35,000.00.

Lac dye (by product of lac) from dye enriched wash water of batch washing was also recovered as per standard IS: 12921-1990 and analyzed. It was observed that maximum dye was only recovered from dye enriched wash water of 1st batch washing with more than 50 per cent dye content and lighter in colour compared to lac dye recovered from wash water of subsequent batch washing.

3.2 Establishment of Pilot-plant of dewaxed decolourised lac for training, demonstration and process refinement

Process validation and optimization for up-scaling the process and development of Pilot plant

Further preparation of dewaxed decolourised lac (DDL) was carried out for process-validation and optimization helpful in up scaling the process. Eight trials were carried out from batch 100 gm and 150 gm seedlac varying lac-solvent ratio 1:8 and 1:6 as per details given in Table 12 with 20 % and 10 % charcoal treatment.

Table 12. Process validation and optimization for up-scaling the process

Sl. No.	Color of seed lac	Charcoal (%)	Lac-solvent ratio (w/v)	Yield (%) of DDL	Color of DDL	Wax (%)	Impurity (%)	Acid value	Flow (mm)	Life (min.)
1	6	20	1:8	75	4	0.99	0.05	74.8	60	10
2	6	10	1:6	68	ND	ND	ND	ND	Nil	Nil
3	5	10	1:6	45	4.2	-	0.88	67.69	52	36
4	5	10	1:6	58	3.4	-	0.96	71.06	72	39
5	5	20	1:6	70	3.8	0.50	0.10	67.72	34	36
6	5	20	1:8	72	3	1.21	0.24	74.83	64	18
7	12	20	1:6	62	4	1.76	3.07	70.82	20	23
8	12	20	1:6	72	To be tested from QEL					

ND: Not determined

Wax removals were carried out in thick jeans cloth in place of filter paper of lab process suitable for up-scaling. Hot filtration of charcoal was also carried out in thick cloth in place of filter paper used in lab process tried in earlier trials so that process can be up-scaled. Filtration time in case of thick cloth was lower 1 hr approx. compared to 2-3 hrs taken in filtration with filter paper for charcoal removal and solution was clear free from charcoal. So, from different trials carried out for preparation of DDL it has been observed that increasing solvent in lac-solvent ratio there was trend of retaining lesser amount of resin with impurities during filtration when measured in lab and resulted in better yield. The moisture content of wet sample before cooking/ heat treatment was found between 55 to 99% by dry weight of DDL and in dried samples it varied between 1.32 to 2.39% by dry wt. of DDL samples. In last three trials fresh charcoal was used for decolourisation and colour reduction from 12 to 4 was achieved with slight better decolourisation. The colour value of DDL samples were also evaluated in Hunter Colorimeter and lightness of DDL samples were found to be 29.87 to 23.37. In 2nd trials over heating during cooking was found to down the quality of DDL which indicates importance of this process which needs to be done carefully. The yield of DDL in this trial was found up to 75% (Fig. 39a & b). The use of thick cloth in place of filter paper was found to decrease the filtration time of charcoal from 2-3 hrs. to 1 hrs.

Fig. 39a: DDL sample from 10% charcoal treatment

Fig. 39b: DDL sample with 20% charcoal treatment

So from the study on DDL preparation including previous 07 trials carried earlier apart from the present 08 trials in increasing solvent ratio in lac from 1:4 to 1:10 resulted in better filtration and better yield due to lesser retaining of wax and resin on filter media during filtration. The solvent ratio 1: 6 and above was found suitable for filtration during wax and charcoal removal and better yield (minimum-75%).

3.3 Biodegradation studies on lac resin using soil burial method

Project commenced *w.e.f* April 1, 2016. Experimental plot was identified and prepared in IRF and simultaneously, pots were also prepared, with compost treatment. *Kusmi* sticklac was obtained from IRF, which was converted to sticklac in PDU and further converted to shellac under personal supervision in commercial lac factory, Balrampur (WB)

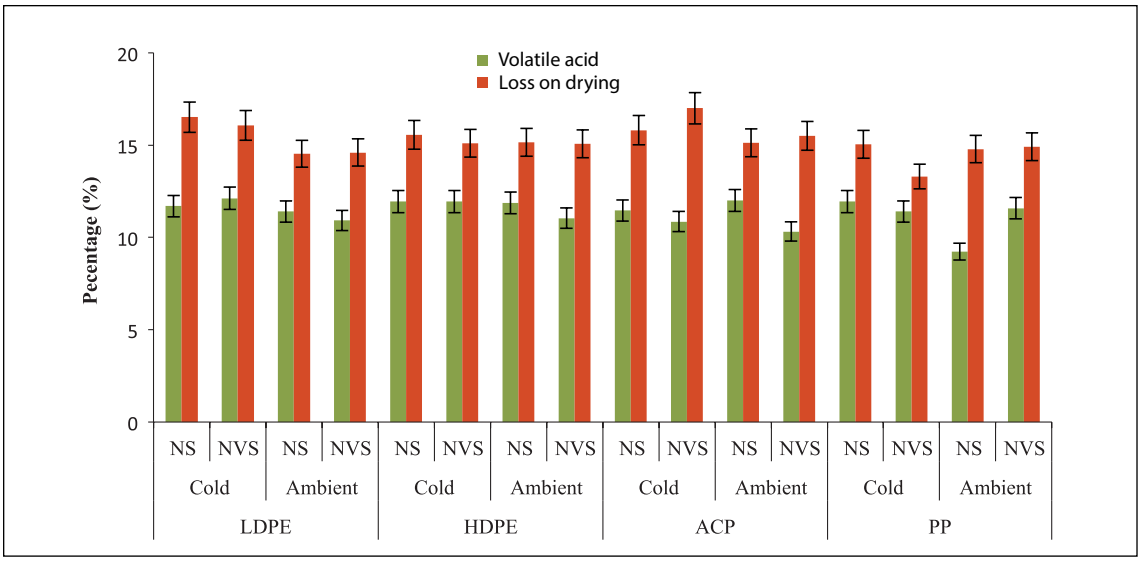
The sticklac, seedlac and shellac samples were accurately weighed, encased in synthetic netting and buried in soil in field and pot conditions. Initial physico-chemical analysis: flow, life, cold alcohol insoluble, color, SEM, FT-IR and DSC of the lac samples and soil samples for microbial profile were also determined in triplicate, to serve as reference point for future data.

3.4 Control of deacetylation of gum *karaya* during storage for quality retention

The samples of gum *karaya* (each weighing 50 g) were packed in LDPE, HDPE, ACP and PP films with normal sealing and vacuum packaging with nitrogen filling and kept them in ambient and cold conditions with 3 replicate for each film. The analysis of packed gum *karaya* sample (3rd and 4th quarters) for the determination of the parameters like loss of drying (percent by mass), volatile acid (percent by mass) swelling property and water absorption was carried out.

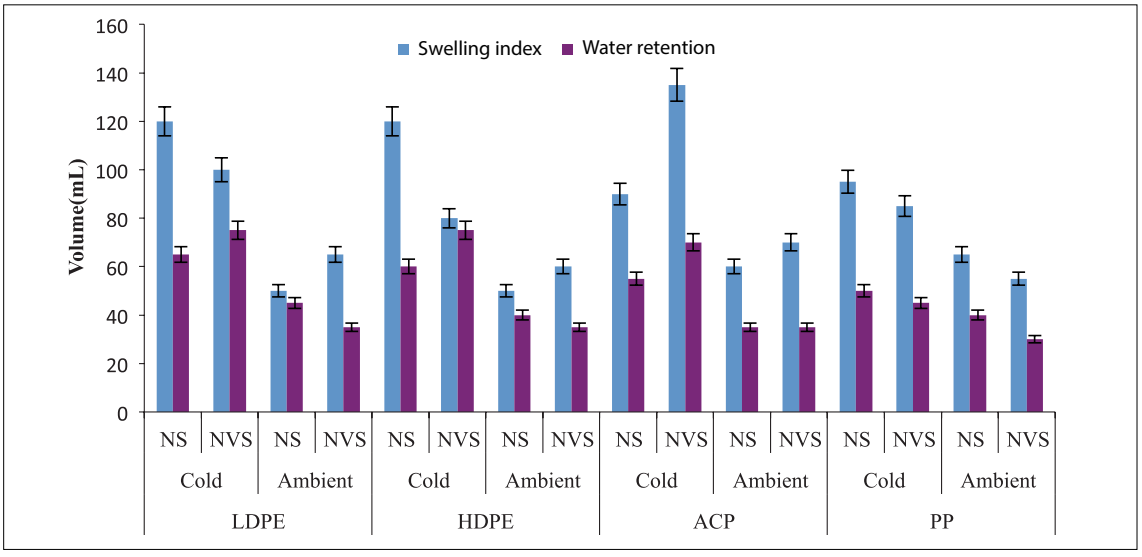
On comparing the data of 3rd quarter for acid value (%) of the gum *karaya* samples packed in LDPE, HDPE, ACP and PP (1) films with normal seal and kept at ambient temp, (2) filled with nitrogen gas and kept

at ambient temp., (3) film with normal seal and kept at cold temp., (4) filled with nitrogen gas and kept at cold temp. showed that there was not much change in the acid value among all the above treatments (Fig. 40). But swelling index showed higher value for the samples of gum *karaya* kept in cold condition with normal seal and vacuum packaged nitrogen seal as compared to the samples kept in ambient condition with normal seal and vacuum packaged nitrogen seal (Fig. 41). On comparing the data of 4th quarter for acid value (%) of the gum *karaya* samples packed in LDPE, HDPE, ACP and PP (1) films with normal seal and kept at ambient temp, (2) filled with nitrogen gas and kept at ambient temp., (3) film with normal seal and kept at cold temp., (4) filled with nitrogen gas and kept at cold temp. showed higher acid value (%) (Fig. 42). and swelling index (Fig. 43) for the samples of gum *karaya* kept in cold condition with normal seal and vacuum packaged nitrogen seal as compared to the samples kept in ambient condition with normal seal and vacuum packaged nitrogen seal.



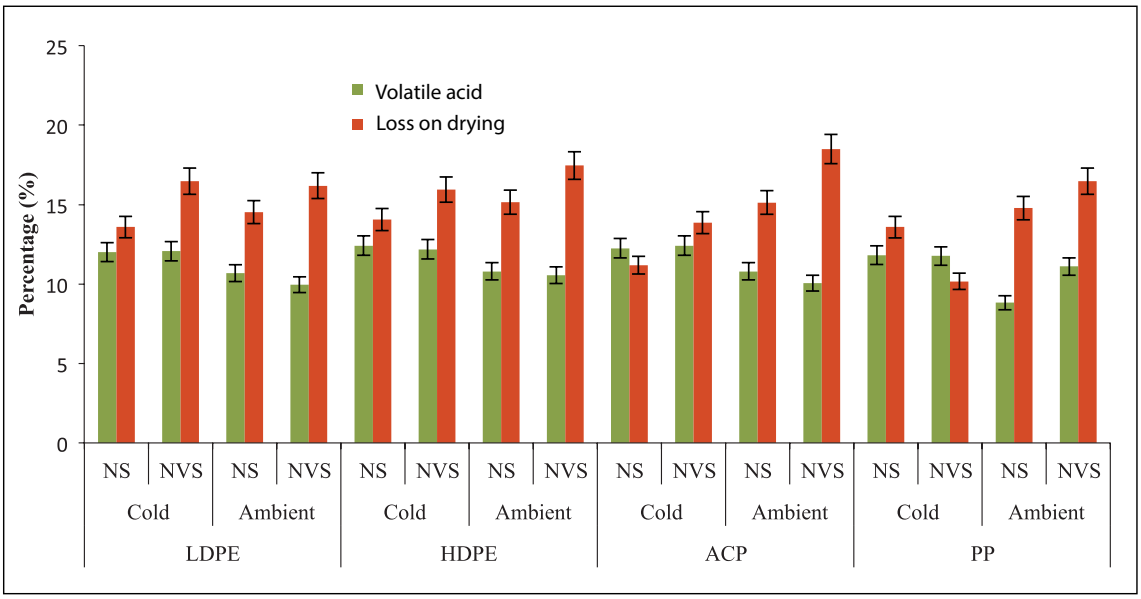
NS= Normal seal; NVS= Nitrogen sealing with vacuum packaging

Fig. 40: Effect of packaging material and storage condition on volatile acid and loss on drying of gum *karaya* samples (3rd quarter)



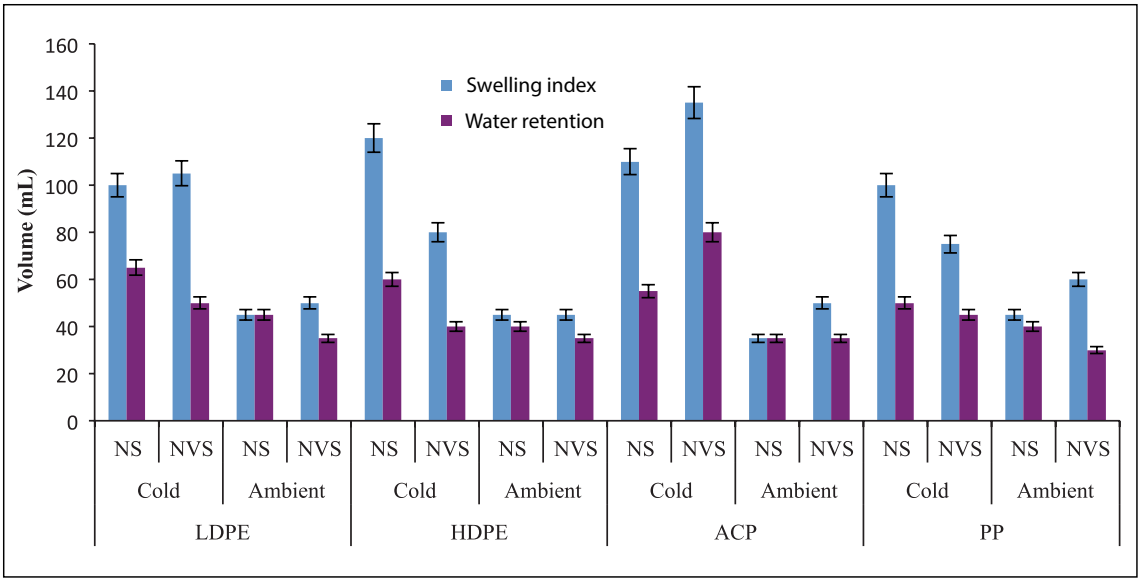
NS= Normal seal; NVS= Nitrogen sealing with vacuum packaging

Fig. 41: Effect of packaging material and storage condition on swelling index and water retention of gum *Karaya* samples (3rd quarter)



NS= Normal seal; NVS= Nitrogen sealing with vacuum packaging

Fig. 42: Effect of packaging material and storage condition on volatile acid and loss on drying of gum *karaya* samples (4th quarter)



Normal seal; NVS= Nitrogen sealing with vacuum packaging

Fig. 43: Effect of packaging material and storage condition on swelling index and water retention of gum *karaya* samples (4th quarter)

An experiment was conducted to demonstrate how the swelling index of samples of gum *karaya* kept in cold condition with normal seal and vacuum packaged nitrogen seal alongwith the samples kept in ambient condition with normal seal and vacuum packaged nitrogen seal behave under above storage conditions. For which 1.0 g each of the samples of gum *Karaya* stored under cold condition with normal seal and vacuum packaged nitrogen seal alongwith the samples kept in ambient condition with normal seal and vacuum packaged nitrogen seal were taken in separate 500 ml graduated cylinders containing 500 ml water and allowed to swell for 18 hours. The observations were recorded after 18 hours and it clearly showed the higher swelling index (white portion of measuring cylinder) for the samples of gum *karaya* kept in cold condition with normal seal and vacuum packaged nitrogen seal as compared to the samples kept in ambient condition with normal seal and vacuum packaged nitrogen seal (Fig. 44).

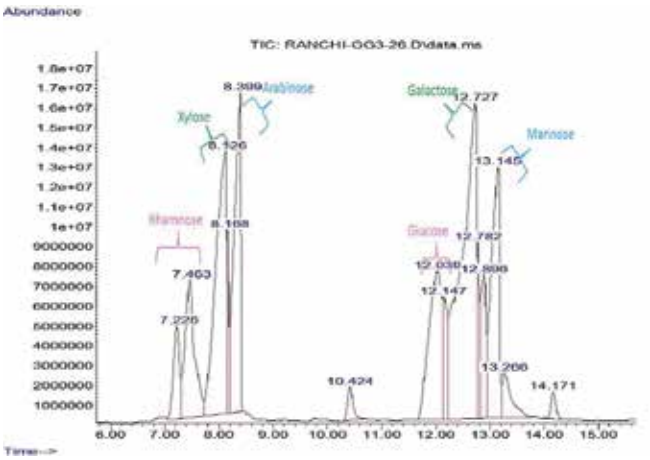
Fig. 44: Swelling index for the samples of gum *Karaya* under different storage conditions

3.5 Characterization, chemical profiling and evaluation of gum *ghatti* (*Anogeissus latifolia* Wall.)

Alditol derivatives of different grades of gum *ghatti* were prepared by hydrolysis with sulphuric acid. Hydrolyzed gum was neutralized, filtered and dried. Acetylation was done with acetic anhydride and pyridine. Unreacted reagents were removed from reaction mixture. Acetylated alditol derivatives were partitioned with dichloromethane, concentrated and stored for GC-MS analysis. Similar process was also followed for acetylation of standard monosaccharides.

All synthesized derivatives of gums as well as standards were analyzed by Agilent technology-GC-MS (with 5975 C, inert XL EI/CI MS detector) at Division of Agricultural Chemicals, ICAR-IARI, New Delhi. The MS method was standardized to get optimum separation and then all samples were analyzed following standardized method.

The separated peaks for different monosaccharides were identified by Agilent MS-Library and also confirmed by matching with the standard monosaccharide chromatograms. Based on the areas of peaks from the software analyzed database, the percentage composition of each monosaccharide, including uronic acids, were calculated (Fig. 45).



Gum Content	80 ± 3.44 %
Rhamnose	8.30 ± 0.10 %
Xylose	13.72 ± 0.23 %
Arabinose	9.00 ± 0.11 %
Glucose	10.57 ± 0.19 %
Galactose	21.82 ± 0.6 %
Mannose	14.04 ± 0.36 %
Glucuronic acid	1.98 ± 0.02%
Galacturonic acid	0.57 ± 0.001 %

Fig. 45: GC-MS chromatogram of the gum *ghatti* and its monosaccharide composition

3.6 Physico-chemical characterization and monosaccharides profiling of *Jhingan* gum

Jhingan gum samples obtained from Bilaspur (Chhattisgarh) were tested according to standard protocol for comparison. UV-Vis absorption scans of dilute solutions (0.25% w/v in distilled water) by UV-Vis Spectrophotometer (CECIL: CE-7200) from 190 nm to 900 nm (Fig. 46) were recorded. Interestingly

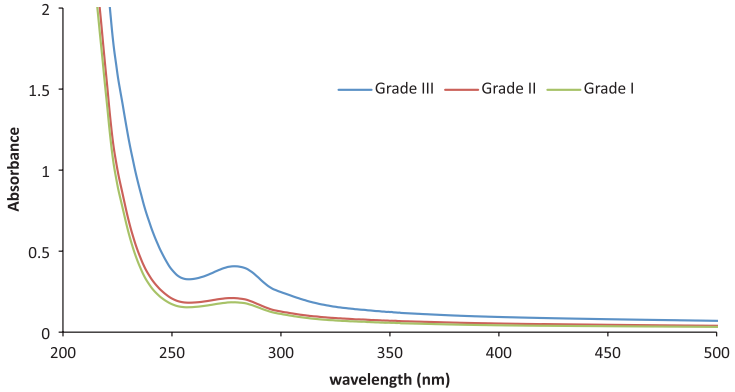


Fig. 46: UV-Vis of *jhingan* gum (Grade-I, II & III)

all the three grades showed characteristic absorption band between 270-290 nm which may be due to the presence of tannin in the gum.

Specific optical rotation of the solutions of different grades of *jhingan* gum was recorded with the Rudolph Polarimeter. The specific optical rotation for *jhingan* Grade-I, II and III was found to be 9.705, 8.091 and 9.920 respectively.

FT-IR spectra of *jhingan* gum revealed broad absorption band at 3400 cm^{-1}, corresponding to O-H stretching due to inter and intra-molecular hydrogen bonds. Band at 2931 cm^{-1} is due to C-H stretching absorption whereas 1636 cm^{-1} is due to the free carboxylate groups from uronic acid present in the gum (Fig. 47).

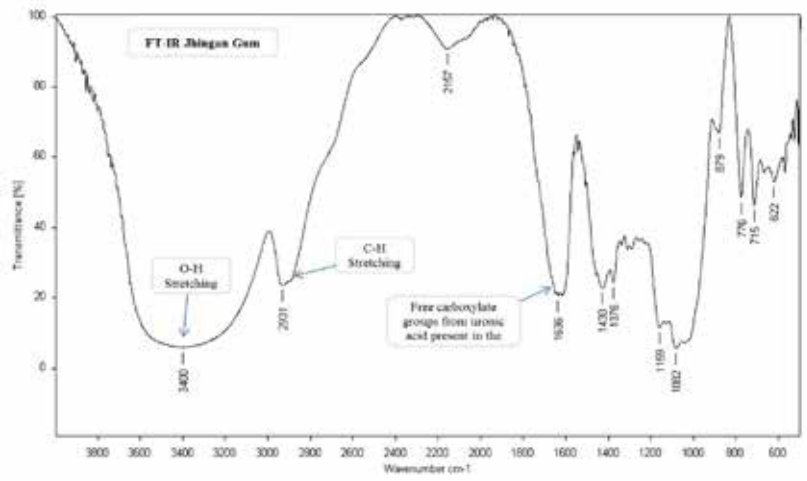


Fig. 47: FT-IR spectrum of *jhingan* gum (Grade-I)

Alditol acetate and uronic acid derivatives of *jhingan* gum Grade-I, II and III were synthesized from the purified gum. All synthesized derivatives of gums as well as standards were analyzed by Agilent technology-GC-MS. The MS method was standardized to get optimum separation and then all samples were analyzed following standardized method. The results show that the polysaccharides contain sugars such as Galactose (31.89%), Arabinose (12.82%), Glucose (7.14%), Mannose (4.68), Xylose (4.26%) and Rhamnose (3.92 %). And Also little amount of glucoronic acid to 6.54 % and Galacturonic acid to 1.10% were also present (Fig. 48 & 49).

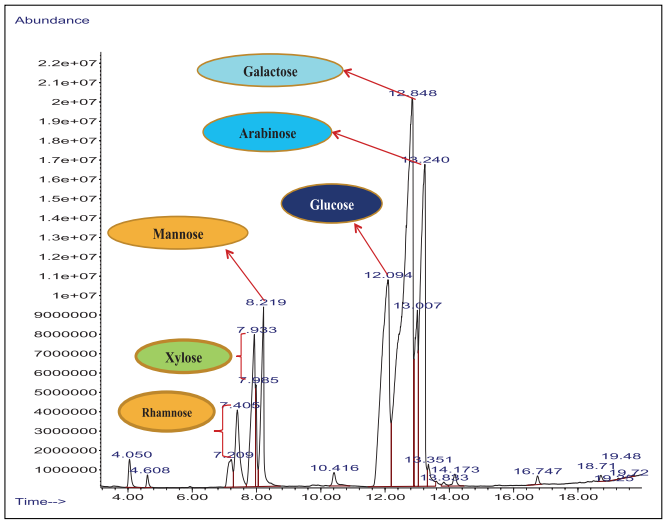


Fig. 48: GC-MS spectra of *jhingan* gum showing various monosaccahride components

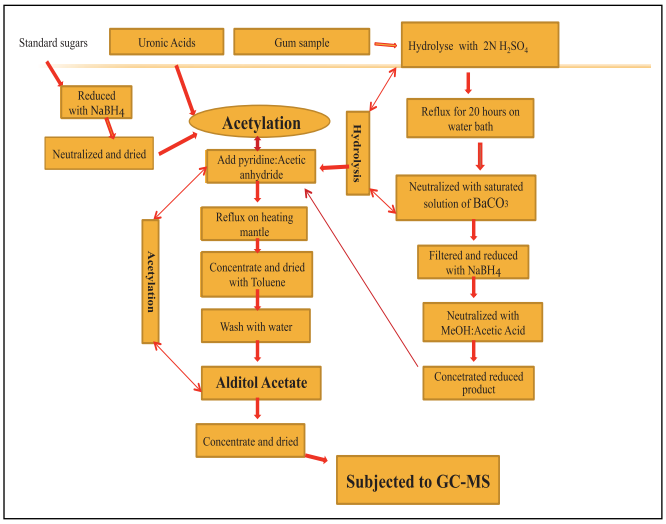
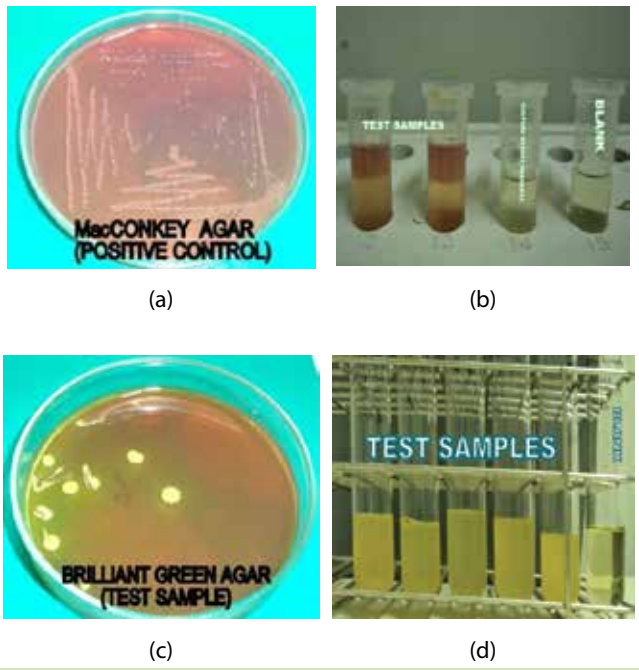


Fig. 49: Flow chart diagram of alditol acetate preparation

For detection of *E. coli* in *jhingan* gum samples, the BIS standard, IS: 5887 (Part I): 976 was followed. Briefly, *jhingan* gum samples were suspended in pre-enrichment medium (peptone water) and incubated, the selective enrichment was done in mediums. The presumptive colonies of *E. coli* obtained were tested using different biochemical tests. Based on the biochemical tests, it appeared that the presumptive colonies so obtained may not be *E. coli*. Besides this experiment, all the grades were also tested on commercially available selective medium for *E. coli* and found to be absent in all the samples

For detection of *Salmonella* in *jhingan* gum samples, the BIS standard, IS 5887 (Part 3): 1999 IS0 6579: 1993 was followed. For pre-enrichment, *jhingan* gum samples were suspended in peptone water and incubated, the selective enrichment was done from the mediums. The enriched samples were placed on selective plating out medium (and also on Hicrome *Salmonella* agar – M1296 of HiMedia). The presumptive colonies of *Salmonella* obtained on BGA were tested using different biochemical tests. Based on the biochemical tests, it appeared that the presumptive colonies so obtained may not be *Salmonella*. Colonies obtained on Hicrome *Salmonella* agar was not *Salmonella* as per the cultural response shown by them (Fig. 50a to 50d).



(a) (b)

(c) (d)

Fig. 50: a) Isolation of *E. coli* **b)** Biochemical tests for *E. coli* **c)** Isolation of *Salmonella* & **d)** Biochemical tests for *Salmonella*

4. Value Addition, Application Development and Product Diversification

4.1 Synthesis and evaluation of cross-linked *guar* gum hydrogels for application in bio-remediation and in agriculture

Synthesis of cross-linked *guar* gum hydrogels was done with varying percentage of borax cross-linker (5, 10, 15, 20 & 25%). Synthesized hydrogels were characterized by absorption capacity, FT-IR, SEM, TGA-DTA analysis. Absorption capacity of the hydrogels at different pH buffers was studied and found around 35 ml/g at pH 4, 45 ml/g at pH 7 and 70 ml/g at pH 9 (Fig. 51 & 52).

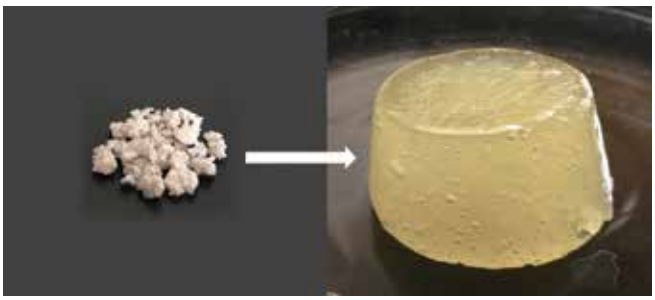
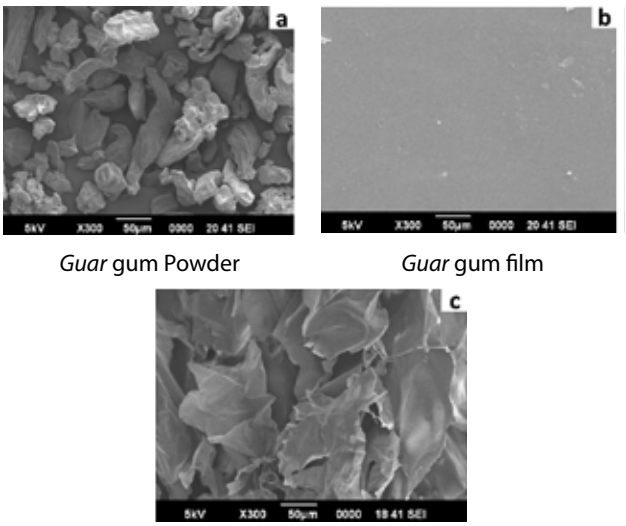


Fig. 51: Cross-linked *guar* gum hydrogels (dried and swollen stage)



Guar gum Powder *Guar* gum film

Guar- Borax Hydrogel

Fig. 52: SEM analysis

The aniline blue dye removal from aqueous solution was studied by using 0.1 g dosage of the different grades of a *guar*-borax hydrogels at 50 mg/dm^3 initial AB concentration for 60 min contact time. During this 60 min exposure time, samples were drawn after fixed interval, scanned in UV-Vis Spectrophotometer and absorbance was recorded at 594 nm (Fig. 53a).

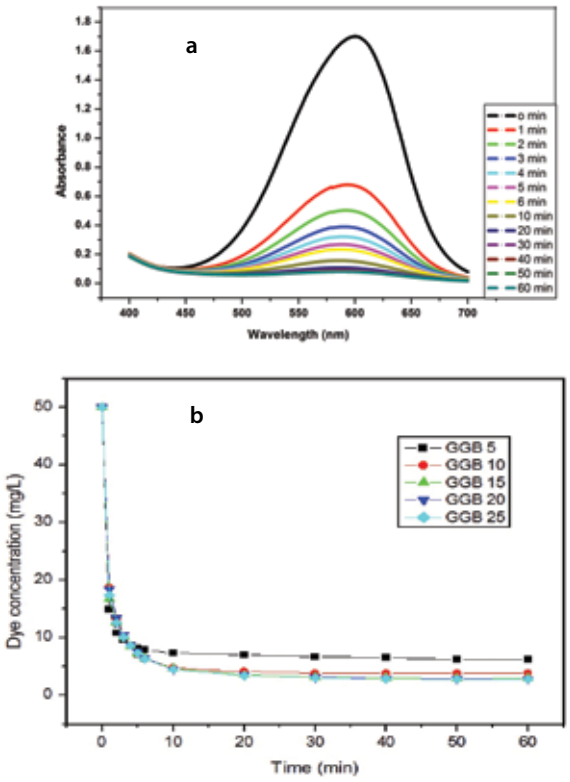


Fig. 53: Aniline blue dye removal studies with *guar*-borax hydrogels, **a)** UV-Vis spectra of dye solution with time **b**) dye concentration with time.

The standard curve for AB absorbance is drawn to calculate drop in dye concentration with time (Fig. 53b). Sudden drop in the dye concentration after addition of hydrogel was found. With increase in cross-linking better dye removal was achieved, which again saturated for hydrogels having borax 15% or more. Decolorization up to 94.30% was achieved within 50-60 min by GGB-15, 20 and 25, all three of which were at par. Whereas, for GGB-5 it was lowest followed by GGB-10, which was recorded around 87.5 and 92.3 %, respectively.

4.2 Development of coating formulation for paper packaging materials

Shellac was modified at ambient temperature in aqueous and non-aqueous solvent system and different coating formulations for paper packaging materials were developed. The formulations were found homogeneous in nature. Films of the formulations were developed on glass slides, tin panels and glass plates. The formulations were also applied on the packaging papers. Films were found smooth, uniform and glossy (Fig. 54). The formulations showed glossiness (30% with reference to standard black 57%) on the paper. Thermal behaviour of the formulations was studied using DSC. The analysis revealed thermal stability of the two samples up to 200 ^{O}C, little softening was recorded around 80 ^{O}C may be because of the presence of wax in shellac (Fig. 55).

Fig. 54: Packaging papers coated with the developed coating formulations

FT-IR analysis of films of the formulations was carried out. Spectra showed interaction of carboxyl and hydroxyl groups of shellac with molecules of reactants. Intensity of carboxyl and hydroxyl groups of shellac decreased on reaction with the reactants (Fig. 56).

Water resistance of the films of the formulations was carried out by dipping the coated glass slides in water. Two formulations showed resistance to water for 7 days as no blushing and detachment of the films were observed. Films of the formulations showed good impact resistance & flexibility. The films did not show any crack, detachment and flaking off of the films on testing the films. Scratch hardness measurement showed films resistance of 1000 g.

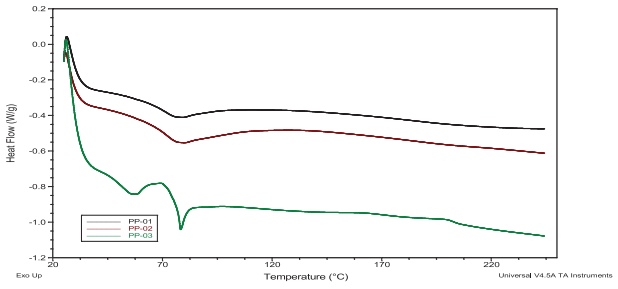


Fig. 55: DSC thermograms of the coating formulations

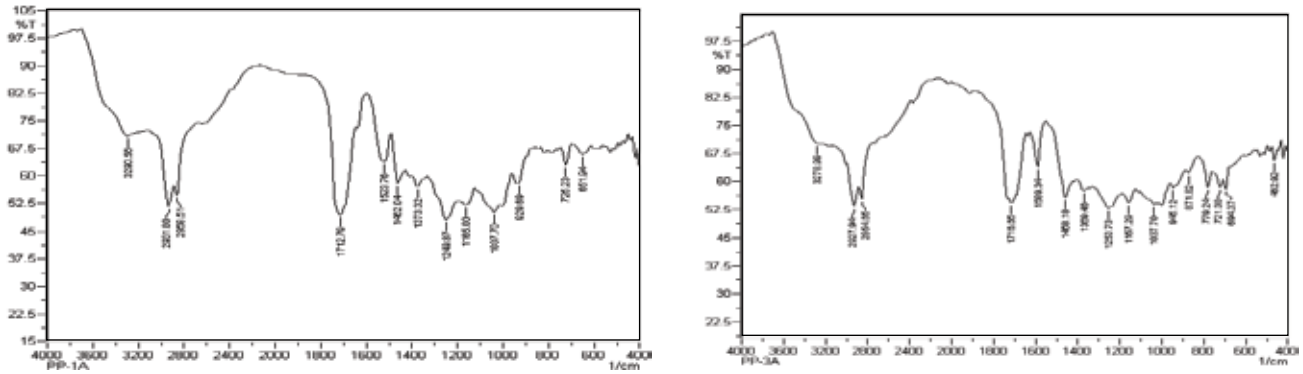


Fig. 56: FT-IR spectra of coating formulations of paper packaging

Mechanical properties such as tensile strength, tensile modulus, elongation per cent and toughness of the packaging papers coated with the formulations were studied with Universal Testing Machine (UTM). Elastic modulus of the coated packaging papers was also calculated. It was recorded that strength of the paper increased significantly after coating the papers (Fig. 57). Highest tensile strength and modulus was found 38.998 MPa and 3.45 GPa respectively. Elongation 2.493 % was recorded the highest. Elastic modulus of the coated paper was calculated to be 18.42 MPa while toughness of the films was 0.616 MPa.

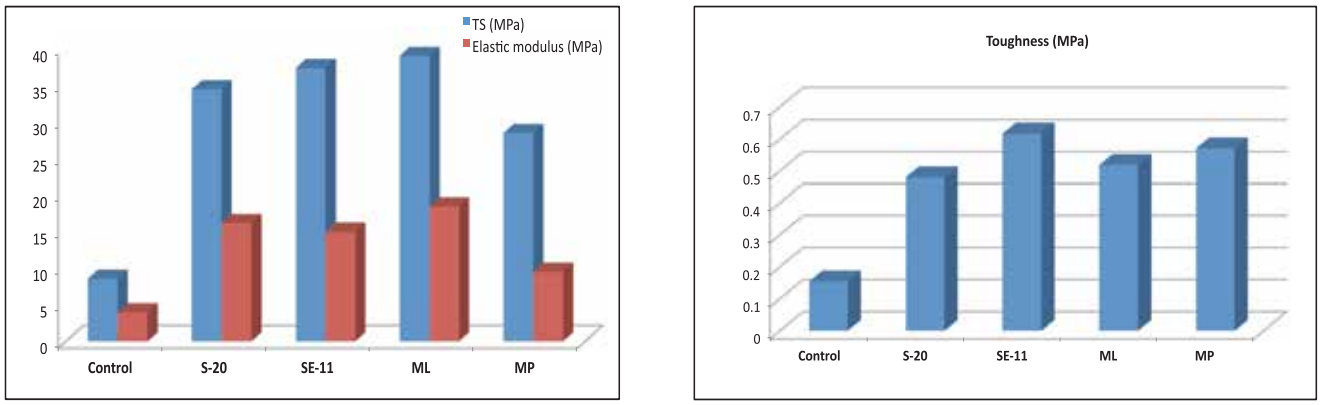


Fig. 57: Strength of the paper packaging materials coated with the developed formulation

Contact angle measurement on the coated packaging papers were carried out against water to observe the hydrophobicity of the coating formulations (Fig. 58). It was observed that hydrophobicity of the packaging paper increased after coating the papers with the coating formulations (Fig. 59).

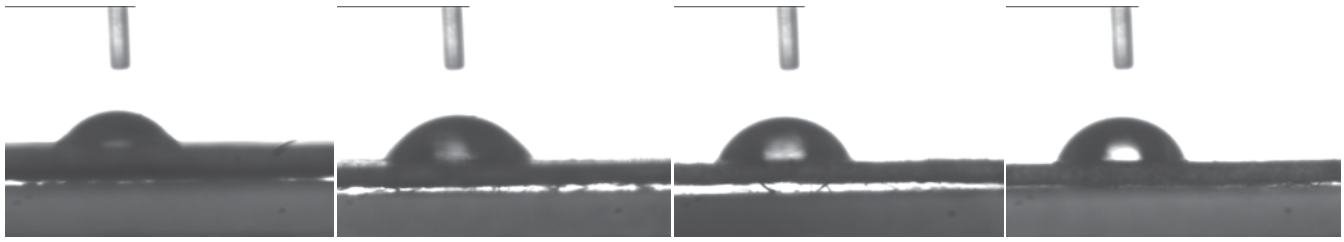


Fig. 58: Contact angle images on the packaging paper coated with the developed formulation against water

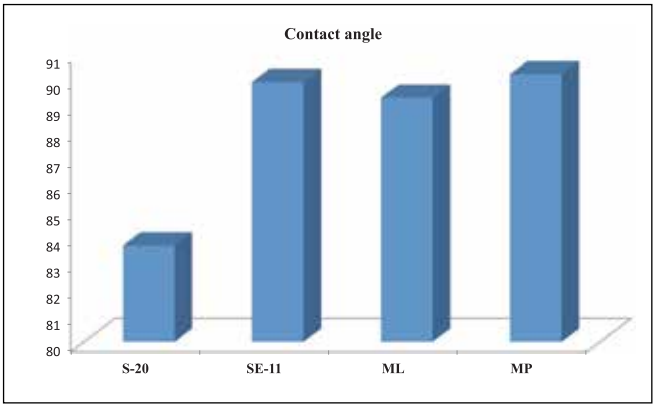


Fig. 59: Contact angle of the paper packaging materials coated with the developed formulation against water

SEM of the coated packaging papers was carried out to see the pores on the paper surface, surface morphology of the packaging papers. The analysis suggested that pores of the paper were blocked with coating of the formulations. Surface of the paper got smoothened and surface evenness was observed after coating the packaging papers with the formulations (Fig. 60).

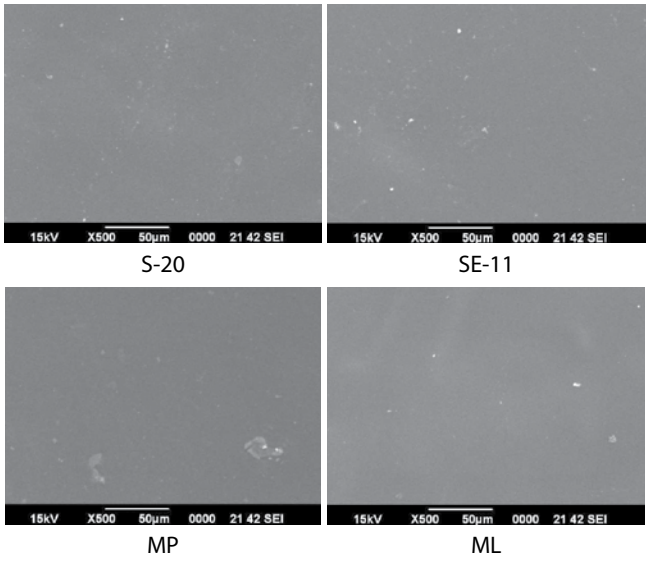


Fig. 60: SEM images of the coated packaging papers

4.3 Green synthesis of silver nanoparticles capped in *Acacia* and *Jhingan* gum for bactericidal application

Synthesis and characterization of *Acacia* gum-based silver nanoparticles

The synthesis of silver nanoparticles (AgNPs) was monitored by UV-Vis spectra at 200 -700 nm, where at 425 nm, a band was detected corresponding to the typical surface plasmon resonance (SPR) of conducting electrons from the surface of AgNPs. Silver ions are reduced to AgNPs by the polyhydroxylated gum and the proteins present in the gum subsequently encapsulate and stabilize these particles along with saccharide molecules (Fig. 61).

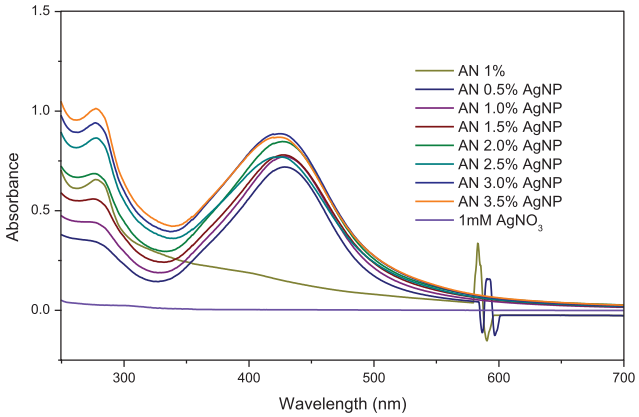


Fig. 61: Effect of concentration on the formation of *Acacia nilotica* gum-based AgNPs by UV-Vis spectra

In FT-IR spectra, the disappearance of broad band at 2137 cm^{-1} (due to various carbonyl groups of gum) at 3.0% gum-concentration confirms that the reduction of the silver ions is coupled to the oxidation of the hydroxyl and carbonyl groups of the gum. Further, shifts in the absorbance peaks from 3143 to 3298 cm^{-1} (due to stretching vibrations of O–H groups), 1597 to1600 cm^{-1} (due to characteristic asymmetrical stretch of carboxylate group) and 1419 to 1384 cm^{-1} (due to symmetrical stretch of carboxylate group) with decreased band intensity is suggestive of the binding of silver ions with hydroxyl and carboxylate groups, respectively (Fig. 62).

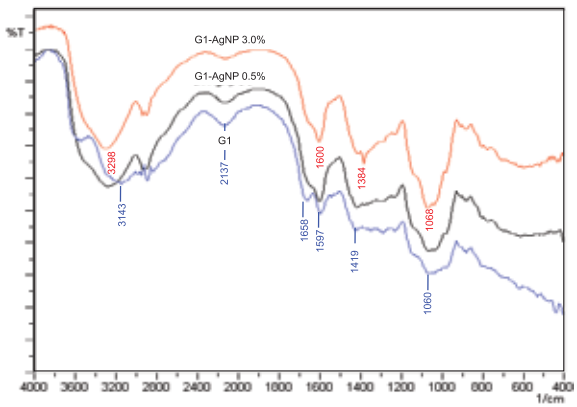
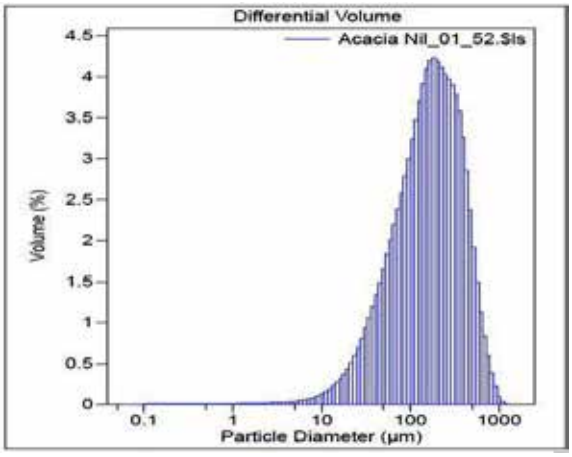


Fig. 62: Characterization of synthesized gum-based AgNPs by FT-IR spectra

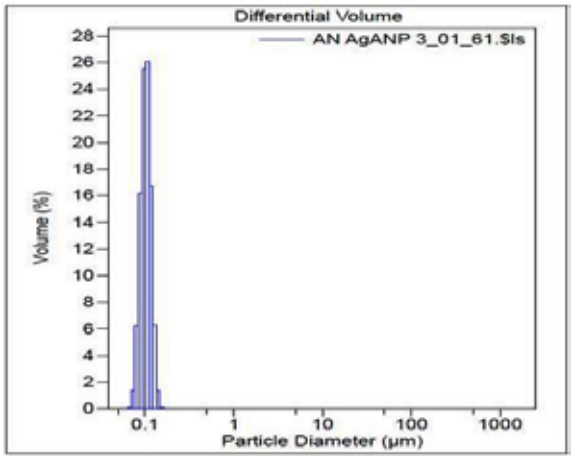
The synthesized *acacia* gum-based AgNPs with 0.5% gum concentration showed zeta potential value -11.8 mV whereas with 3.0 % gum concentration, it was -15.0 mV. Energy Dispersive X-ray Analysis (EDX) equipped with SEM, clearly showed the presence

of elemental Ag peak along with Ca, Mg & Pt, confirming the incorporation of Ag in the synthesized nanoparticles. Morphological features of the *Acacia senegal* gum and its synthesized AgNPs using 0.5 % and 3.0 % gum concentrations were studied with a JEOL JSM-6390 LV Scanning Electron Microscope. The images were taken at an accelerating voltage of 10 KV and at 500 X and 2000 X magnifications and found that the gum has irregular, non-distinct large particles size. On the contrary, the *Acacia* gum-based AgNPs's surface morphology showed quite distinct inter-woven net like structures.

Analysis of *Acacia nilotica* gum and its synthesized AgNPs by Laser Diffraction Particle Size Analyzer revealed the d_{50} values were found to be 165.8 µm and 0.102 µm, respectively (Fig. 63).



Acacia nilotica gum, d_{50}: 165.8 µm



Acacia nilotica –AgNPs , d_{50}: 0.102 µm

Fig. 63: Laser Diffraction Particle Size Analysis of *Acacia nilotica* gum and its AgNPs

Atomic Force Microscopy (AFM), one of the foremost tools, offers not only 2D/3D visualization but also provides both qualitative & quantitative information on the physical properties *viz*. size, morphology, surface texture and roughness of nanoparticles. Statistical information, including size, surface area and volume distribution can be determined as well (Fig. 64 a to c).

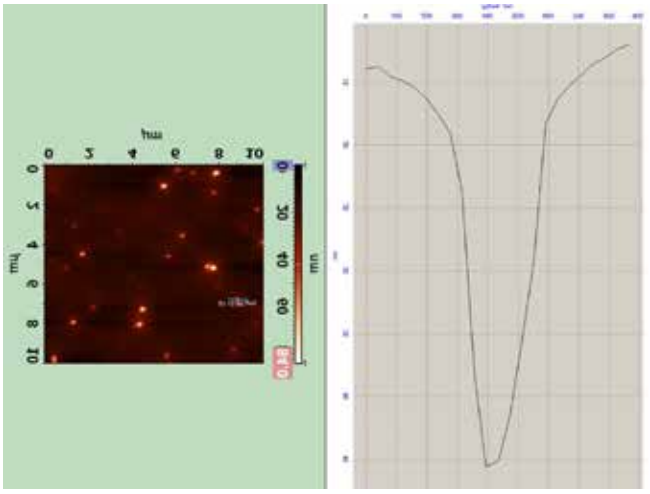


Fig. 64a: 3D image & single particle of *Acacia nilotica* gum-based AgNPs

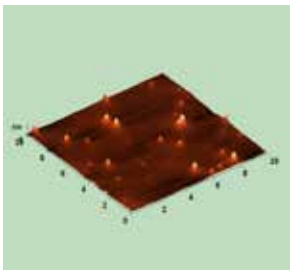


Fig. 64b: 3D image of *Acacia nilotica*-AgNPs, 0.5 %

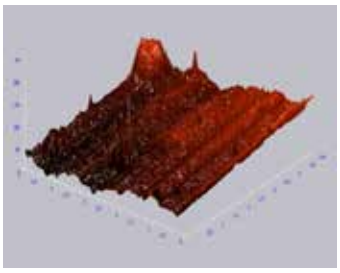


Fig. 64c: 3D image of *Acacia senegal*-AgNPs, 0.5 %

Synthesis and characterization of *Jhingan* gum-based AgNPs

Numbers of reactions were carried out to synthesize AgNPs by reacting different concentrations of *jhingan* (*Lannea coromandelica*) gum exudates collected from Bilaspur (CG) and silver nitrate by autoclaving the reactants at 121^{0}C and 15 psi for standardizing the optimum concentration of the gum to be used. After due standardization *jhingan* gum solution of 2, 3, 4, 5, 6 % were used for the synthesis of *jhingan* gum based AgNPs.

The change in color confirms nanoparticles formation which was confirmed by UV-Vis Spectroscopy. In UV-Vis spectra, strong peaks with maxima around 412-415 nm were observed which increases with the increasing gum-concentration to 6.0%, confirming an enhancement in the nanoparticles synthesis (Fig. 65).

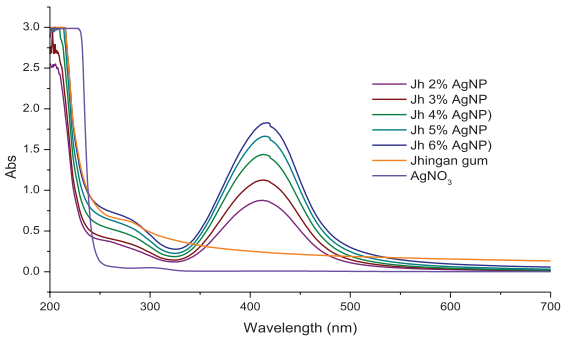


Fig. 65: Effect of concentration on the formation of *Jhingan* gum-based AgNPs by UV-Vis spectra

Synthesized *jhingan* gum-based AgNPs were characterized by Transmission Electron Microscopy (TEM). Result shows excellent formation of nanoparticles (Fig. 66).

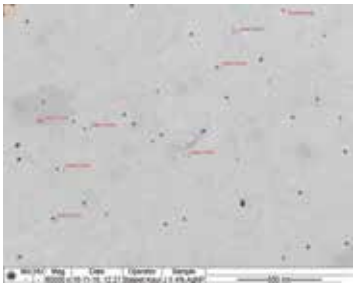


Fig. 66: TEM analysis of synthesized *Jhinagn* gum-based AgNPs

Analysis of synthesized *jhingan* gum-based silver nanoparticles by Laser Diffraction Particle Size Analyzer revealed the formation of nanoparticles. The d_{50} values of the particles size were found to be in the range of 0.059 to 0.091 µm (Fig. 67).

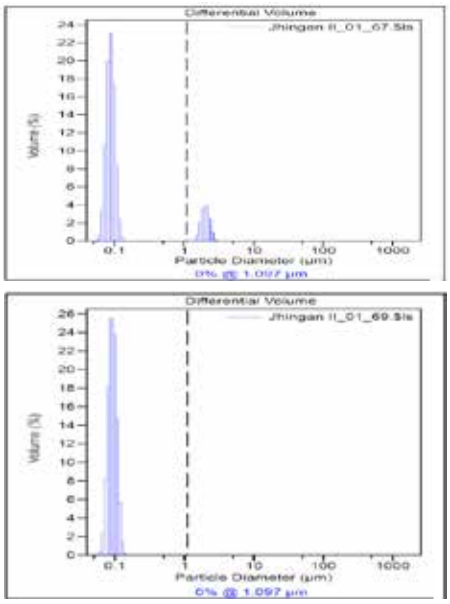


Fig. 67: Laser Diffraction Particle Size Analysis of *Jhingan* gum-based AgNPs

4.4 Natural *gum* based adsorbents for removal of heavy metals from water

Different types of adsorbents were synthesized by the modification of gum *arabic*, gum *karaya* and gum *ghatti*. Novel polymers in the form of a thiolated, aminated and oxygenated derivatives of natural exudate gums were synthesized.

Thiolated gum *arabic* was synthesized by oxidation followed by conjugating with l-cysteine to form thiolated derivative. Thiolated derivatives of gum *karaya* and gum *ghatti* were synthesized by esterification of gums with thioglycolic acid. Oxygenated derivative of gum *arabic* was synthesized by simple oxidation. Aminated derivative of gum *arabic* was synthesized by amination followed by oxidation.

These derivatives were synthesized at different concentration of gums, reagents, solvent and at different time, pH and temperature. These factors were optimized by repeating the reaction and changing one of the factors while keeping other factors constant. In this way the effect of each variable on the efficiency of reaction was determined. Preliminary characterization of synthesized derivatives was carried out using CHNS and FT-IR.

4.5 Synthesis and evaluation of *guar* gum derivatives

The anionic (Carboxymethyl), non-ionic (Hydroxypropyl) and cationic (Hydroxypropyl triammonium chloride) derivatives of *guar* (Fig. 68) were synthesized by semi-dry and non-aqueous method which involves minimum use of organic solvent. The methods of preparation and reaction condition of *guar* gum derivatives were optimized. The method of preparation of *guar* derivative is simple, consistent and perfected to lab scale. Physico-chemical properties of synthesized *guar* derivatives were compared (Table 13) with native *guar* gum. The physico-chemical comparison of derivative clearly indicated the improvement of the properties like solubility, solution clarity and thermo-stability than native *guar*.

The modified method of preparation of *guar* derivative is also economic in the sense that it involves the minimum use of organic solvent which can be further corroborated with the cost analysis of conventional and modified methods. The cost analysis of modified method of preparation of caroboxymethyl derivative is estimated to be 30% lower in comparison to the

conventional synthetic process. In addition to the above, the modified process is also advantageous as it involves the minimum use of organic solvent which makes the process more eco-friendly.

Fig. 68: Carboxymethyl, Hydroxypropyl and Cationic derivative of *guar* gum

Table13. Comparison of physico-chemical properties of *guar* gum derivatives with native *guar*

Physico-chemical parameters	Native *guar* gum	Carboxymethyl *guar*	Hydroxypropyl *guar*	Cationic *guar*
Ionic character	Non-ionic	Anionic	Non-ionic	Cationic
Physical appearance	Free flowing creamish white powder	Free flowing, yellowish and odourless powder	Creamish white and odourless powder	Free flowing, yellowish white and odourless powder
Solubility	Not easily soluble	Easily soluble in water	Easily soluble in water and partially souble in aqueous ethanol	Soluble in water
Hydration time	2 hr	15-30 min	1 hr	30 min
pH (1% aqueous soln.)	6.5 to 7.2 (neutral)	9.69 to 7.06 (alkaline in nature)	7.08 to 7.72 (neutral to slightly alkaline in nature)	5.77 to 6.55 (slightly acidic)
Viscosity (Brookfield Viscometer, 1% solution, LV4 spindle, 20 rpm and 25 ^{0}C)	4000-5000cP	2000-3500 cP	1445 to 1548 cP	2500 cP to 3200 cP
Degree of substitution (Ds)	-	0.12 to 0.25 equivalent to carboxymethyl group equivalent	0.9 to 1.34 hydroxypropyl group equivalent	0.099-0.53 cationic group
Solution clarity	Opaque	Increases with carboxymethylation	No effect	Increases with cationization
Thermo -stability	Poor	Decreases	significantly increases	Slightly increases

4.6 Modification of *guar* and *arabic* gum for potential use as dietary fibre

American Association of Cereal Chemists (AACC) in 2000 defined dietary fibre as the edible parts of plant or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fibre includes polysaccharides, oligosaccharides, lignin and associated plant substances. Dietary fibre is that part of plant material in the diet which is resistant to enzymatic digestion which includes cellulose, noncellulosic polysaccharides. Dietary fibers are the ingredients of foods which the body cannot digest or absorb. They pass without much break-down or relatively intact through whole digestive system. Dietary fiber intake provides many health benefits. Individuals with high intakes of dietary fiber appear to be at significantly lower risk for developing coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal diseases.

Guar gum is a polysaccharide, a long chain made of sugars galactose and mannose. The soluble hydrophilic polysaccharide of *guar* gum is used as an emulsifier, thickener and stabilizer in a wide range of foods and comprises of soluble dietary fiber (SDF) and as well as total dietary fiber (TDF). However, *guar* gum is extremely viscous which results in the liquid products with high viscosity when it is added at a physiologically effective concentration, thereby its utilization may be restricted for dietary fiber supplementation in actual food products, especially for liquid products. It also interferes with absorption of nutrient and decreases the protein and lipid utilization. These problems can be easily overcome by using partially hydrolyzed *guar* gum (PHGG). PHGG produced from *guar* gum by hydrolyzing process has the same chemical structure with intact *guar* gum but less than one-tenth of the original molecular length of native *guar*. The viscosity of the product is substantially reduced and greatly stable against low pH, heat, acid and digestive enzyme. It is now being used commercially in various beverages, food products and medicinal foods as a functional dietary fibre.

Guar gum was hydrolyzed using chemical method under both alkaline and acidic condition at different time interval. Another set of experiment for hydrolyzing *guar* gum was carried out using microwave irradiation in alkaline and acidic conditions. The hydrolyzed product was refined and dried for preparation of dietary fibre. The viscosity of the 1% aqueous solution of hydrolyzed *guar* was estimated using Brookfield Viscometer (Fig. 69 & 70).

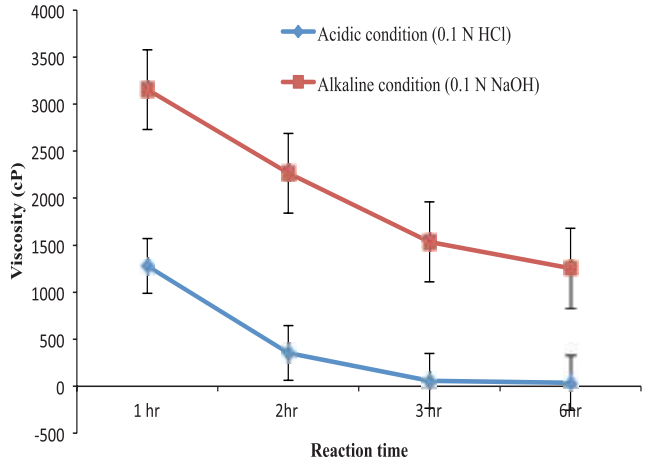


Fig. 69 : Viscosity of the hydrolyzed product of *guar* using conventional hydrolysis process

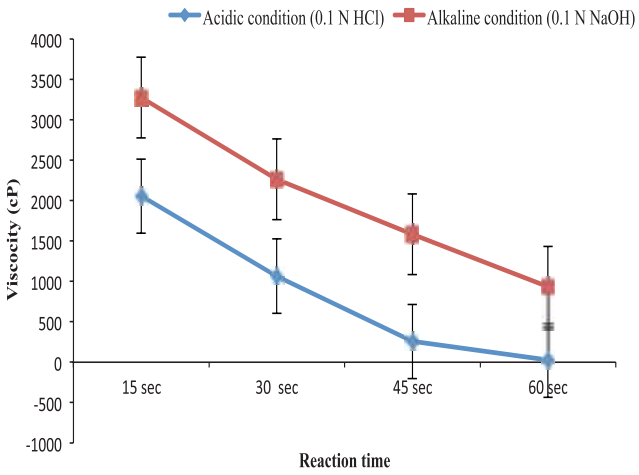


Fig. 70 : Viscosity of the hydrolyzed product of *guar* using microwave irradiation

The viscosity of the acid hydrolyzed *guar* was found in the range 10-30 cP, suitable for application of dietary fibre whereas the alkaline hydrolyzed *guar* resulted relatively higher value (1875-2250 cP). The microwave irradiated hydrolyzed product showed suitable viscosity and the reaction time is significantly reduced than the conventional method (3 hr to 45 seconds).

4.7 Assigned Work

Development of coating formulation for green garbage bags

In response to request made by an organization, efforts were made for developing coating formulation for green garbage bags, to be used for domestic waste disposal. A number of formulations were developed and newspaper materials were coated with the formulations. The coated newspaper materials were studied for mechanical and water bearing properties. Highest tensile strength of the coated paper was observed to be 46.667 MPa (1.5 -2.0 times increase in tensile strength to that of the control sample). Elongation and toughness was also significantly improved. Water barrier property of the coated papers was also studied. The coated papers were made into funnel shape and water was poured into it. It was observed that no drop of water passed through the coated paper even after one week, while water started dropping through the control paper at just 20-25 seconds only.

Transfer of Technology

5. Capacity Building of Farmers and Entrepreneurship Development

5.1 Learning, capacity building, extension education and information services on natural resins and gums

The Institute conducted different types of training programmes pertaining to scientific lac cultivation, processing and utilization under capacity building and entrepreneurship development programme. It continuously assesses the needs of stakeholders and modifies the programmes accordingly. Besides many in-campus programmes, field out-reach activities in terms of training, technical guidance, lac crop monitoring etc. were also undertaken. A summary of courses conducted and number of beneficiaries is presented in Table 14.

Table 14. Skill development programmes on scientific lac cultivation, processing and utilization

Sl. No.	Name of programme	No. of Courses/ Camps	No. of Beneficiaries
Skill Development Programmes			
	Farmers training programme on scientific lac cultivation, processing and utilization (5 days)	18	566
	Master trainers' training programme on scientific lac cultivation, processing and utilization (6 days)	10	332
	Educational programme on production, processing and application of NRG (10/15 days)	05	171
	Short term training program (Refresher Course) on scientific lac cultivation, processing and uses (3 days)	02	57
	Lac based product demonstration training (3-10 days)	15	24
	Sub-total	**50**	**1150**
Other training programme			
	On-farm training programme on scientific lac cultivation	14	1080
	On-farm Motivational/supplementary training programme on lac cultivation	14	856
	In-campus one-day orientation programme on lac cultivation	69	3471
	Sub-total	**97**	**5407**
	Total	**147**	**6557**

Farmers training programme on scientific lac cultivation, processing and utilization

The programme on scientific lac cultivation processing and utilization is for one week and it constitutes lac cultivation, processing at farm level and its uses. A total of 566 farmers from different districts of four states *viz.* Jharkhand, Chhattisgarh, West Bengal and Madhya Pradesh participated in the programme. The participants were sponsored by various organizations and details are given in Appendix-I.

Master Trainers' training programme on scientific lac production, processing and utilization

Master Trainers, unemployed educated rural youth (lac facilitator), junior lac executives, managers, primary forest committee members participated and trained under Trainers' training programme on scientific lac production, processing and utilization. A total of 332 participants were trained as trainers through 10 different courses. These were sponsored by various organizations of Jharkhand, Assam, Chhattisgarh,

Madhya Pradesh, West Bengal, Karnataka, Andhra Pradesh and Maharashtra States (Appendix-I).

Educational programme on production, processing and uses of natural resins and gums

Different educational institutions namely Sam Higginbottom Institute of Agriculture Science & Technology, Allahabad (Formerly Allahabad Agriculture Institute, Allahabad); Institute of Agriculture Sciences, Banaras Hindu University, Varanasi (UP); Guru Ghasidas University, Bilaspur (Chhattisgarh); NG Ranga Agricultural University, Hyderabad; St. Xavier's College, Ranchi and Department of Rural Technology & Development, University of Allahabad (UP) have nominated their agricultural graduate and postgraduate students to participate in ten and fifteen days education programme on production, processing and application of natural resin and gums. A total of 171 students participated through five courses under this educational programme scheme (Appendix-I).

Short term training program (Refresher Course) on scientific lac cultivation, processing and uses (3 days)

Three days Refresher Course on scientific lac cultivation, processing and uses for Ajeevika Vanopaj Mitras (AVMs) was organized during the months of November and December 2016 and sponsored by Jharkhand State Livelihood Promotion Society (JSPLS), Jharkhand. A total of 57 stakeholders participated through two courses (Appendix-I).

Product demonstration training

Short term lac based product demonstration training organized for self-sponsored participants of different states on aleuritic acid, dewaxed bleached lac, lac based varnishes, lac dye etc. (Table 15).

Table 15. Lac based product demonstration training

Sl. No.	Name & Address	Sponsoring Agency	Duration	Subject
1.	Shri Aloke Kumar, M/s Renshel Exports Pvt. Ltd., Kolkata	Self	06.02.16 to 15.02.16	Lac Dye (Tech. Grade)
2.	Shri Aloke Kumar, M/s Renshel Exports Pvt. Ltd., Kolkata	Self	06.02.16 to 15.02.16	Gasket Shellac Cement Compound
3.	Shri Vivek Agarwal, M/s Ganga Lac Factory, Khunti (Jharkhand)	Self	08.02.16 to 14.02.16	Dewaxed Decolourized Lac
4.	Group of 10 participants	KVK, Rajnadgaon	03.3.16 to 05.3.16	Lac Processing (Seed Lac)
5.	Sri Roshan Tirkey, Bano, Simdega (Jharkhand)	Self	03.5.16 to 09.5.16	Lac Processing (preparation of seedlac from sticklac)
6.	Md. Jawed, from M/s JJ Sales, Kantatoli Chowk, Ranchi (Jharkhand)	M/s JJ Sales, Kantatoli Chowk, Ranch	03.5.16 to 09.5.16	Lac Wood Shine (Melfolac), Water Soluble Lac and Lac Glaze (Shellac based glazing varnish)
7.	Mr. Wei Hu & Mr. Swarup Dutta, M/s Anning Decco Fine Chemical Ltd. Kunming, Yunnan, China	M/s Anning Decco Fine Chemical Ltd. Kunming, Yunnan, China	13.7.2016 to 14.7.2016	Aleuritic Acid
8.	Sri Kumar Parash Mani, M/s Expert Wings Chemicals, Lalpur, Ranchi (Jharkhand)	M/s Expert Wings Chemicals, Lalpur, Ranchi (Jharkhand)	18.7.2016 to 27.7.2016	Dewaxed Bleached Lac
9.	Sri Vijay Kumar, M/s Expert Wings Chemicals, Lalpur, Ranchi (Jharkhand)	M/s Expert Wings Chemicals, Lalpur, Ranchi (Jharkhand)	18.7.2016 to 27.7.2016	Dewaxed Bleached Lac
10.	Sri Ajay Kumar, Durgapur (West Bengal)	Self	26. 7.2016 to 28. 7.2016	Lac Wood Shine (Melfolac) and Lac Glaze

Sl. No.	Name & Address	Sponsoring Agency	Duration	Subject
11.	Sri Mahesh Sharma, Korba, Chhattisgarh	Self	25.7.16 to 03.8.16	Aleuritic Acid and Dewaxed Decolourized Lac (DDL)
12.	Sri RL Hanwat, Smt. Dulan Devi Pardhi Bahuddeshiya R & D Sansthan, Waraseoni, Balaghat (M P)	Self	26.9.16 to 29.9.16	Water Soluble Lac, Gasket Shellac Cement Compound, Air-drying type Insulating Varnish, Non-spirit Varnish for Wooden Surface and Gummy Mass
13.	Sri CL Pardhi, Smt. Dulan Devi Pardhi Bahuddeshiya R&D Sansthan, Waraseoni, Balaghat (MP)	Self	26.9.16 to 29.9.16	Water Soluble Lac, Gasket Shellac Cement Compound, Air-drying type Insulating Varnish, Non-spirit Varnish for Wooden Surface and Gummy Mass
14.	Sri Eklavya Lath M/s Lab One, Pandri, Raipur (Chhattisgarh)	Self	19.9.16 to 01.10.16	Aleuritic Acid and Isoambrettolide Technologies
15.	Sri Premnath Keshri, Main Bazar, Sikandara, Jamui (Bihar)	Self	03.10.16 to 05.10.16	Lac Glaze (Shellac based glazing varnish)

On-farm training programme on scientific lac cultivation

ICAR-IINRG has organized fourteen on-farm training programme on lac cultivation in collaboration with various GOs and NGOs. A total of 1080 farmers were participated from different districts of Jharkhand. The participants were nominated by Forest Divisions of Jharkhand and a NGO, namely Chotanagpur Vikas Nidhi, Lachragarh, Simdega (Appendix-II).

On-farm, motivational/ supplementary training programme on lac cultivation

A total of 856 participants were trained in on-farm motivational/ supplementary training programme on lac cultivation in collaboration with various NGOs and GOs of Jharkhand and Meghalaya. The participants represented five districts of Jharkhand *viz*. Ranchi, Khunti, Saraikela-Kharsawan, West Singhbhum and Ramgarh and from Shillong in Meghalaya (Appendix-II).

In-campus one-day orientation programme on natural resins and gums

In-campus, one day orientation programme (69 Nos.) on natural resins and gums were organized in collaboration with GOs and NGOs of different states and a total of 3471 numbers of farmers, school children, college students and executives were visited the institute for this purpose. These were nominated by various agencies (Appendix-III).

NRG Information Cell (NIC) and Market Oriented Technical Advisory Services (MOTAS)

During 2016, information related to the production, price/minimum support price (MSP), marketing, processing and export has been disseminated through the verbal, writing, telephonic and mails to a total of 169 stakeholders including farmers, traders, exporters, processors / manufactures, research scholars, extension personnel's of GOs, NGOs, etc. (Appendix-IV). Beneficiaries belonged from 13 states including other country (Nepal) (Fig. 71).

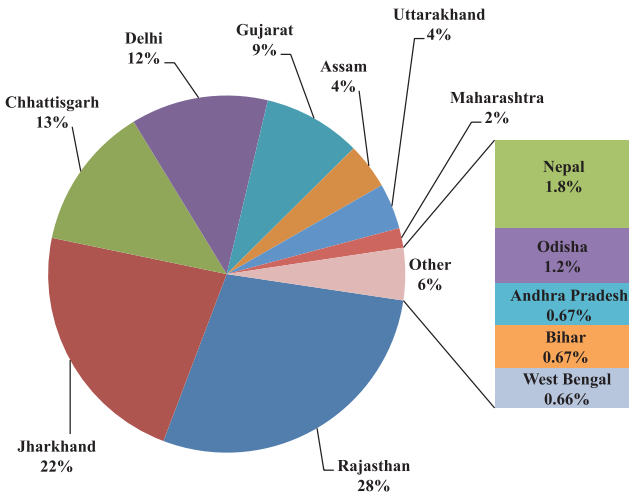


Fig. 71: State wise beneficiaries under NIC and MOTAS

5.2 Information, Communication and Technology (ICT) intervention on Natural Resins & Gums (NRGs) knowledge dissemination system

In the first phase, preparation of five video films have been started for lac cultivation on *kusum*, *palas*, *ber* and *F. semialata*. Shooting of video films and writing of scripts were coordinated for the video documentation activities with the approved agency and experts of the Institute. Script writing for 14 video films is in progress.

6. Technology Evaluation, Refinement, Dissemination and Demonstration

6.1 Impact assessment and market research on NRGs

Market research on NRG: About 1997 stakeholders including 223 institutions, 998 farmers, 158 traders, 44 processors/wholesalers/exporters, 481 resource persons were interacted through visits and telephonic conversations in 58 districts of 17 states. Secondary data on NRG about production were collected from various central and state government organizations. Due to high market price fluctuation particularly for *guar* gum during 2015-16, total production of NRGs has decreased from 1120124.50 tons in 2014-15 to 844646.00 tons in 2015-16 (Table 16). It showed a decrease of about 25 % over the previous year. However, the price of *guar* gum remained stable at lower level during 2016-17. During previous 15 months, due to private sector monopoly and lack of organized / public sector lac processing infrastructure, the market price for lac has been lower than the MSP declared by GOI.

Table 16. Total NRG production, export and import during 2010-11 to 2015-16

Year	Total NRG	Export		Import	
		Quantity (in tons)	Value (in ₹lakhs)	Quantity (in tons)	Value (in ₹lakhs)
2010-11	674701.72	377311.60	308622.90	68750.76	67950.40
2011-12	772549.09	641570.16	1696636.17	80734.60	71497.81
2012-13	849139.85	340384.75	2176118.62	89746.33	78534.90
2013-14	1159137.23	483060.85	1217055.20	89535.92	96501.64
2014-15	1120124.50	543620.51	963270.94	86189.81	107413.18
2015-16*	844646.00	272462.21	343995.98	96387.62	129169.37

*Advance estimates of production figure (includes only gums and pine resins)

On the basis of survey in the markets and processing centers of different lac producing states, the estimated national production of sticklac during 2015-16 was approximately 18,746 tons (Fig. 72). Jharkhand state ranks 1st followed by Chhattisgarh, Madhya Pradesh, Maharashtra and Odisha. These five states contribute more than 90% to the national lac production (Fig. 73). Total production of lac was observed around 10.41% higher than the previous year and 15.3% increase in lac production was recorded in Jharkhand. A decline in lac production is expected during 2016-2017.

The data on prices of *rangeeni* and *kusmi* sticklac and seedlac have been collected from the lac markets on quarterly basis. Price of *rangeeni* and *kusmi* sticklac was shown decreasing trend from January 2014 to June 2016. The information on the price revealed that price range of *kusmi* sticklac and *rangeeni* sticklac at various levels of markets has improved slightly since September 2016. Subsequently, the per kg price of processed lac products namely, seedlac, shellac, button lac and bleached lac also improved (Fig. 74). Other resins and gum production is declined this year also. Overall, NRG production level during 2015-16 is estimated comparatively lower than the previous year. Lac processing in India during previous seven years is shown in Fig. 75. The collection rate for gum *karaya* for the year 2016 was fixed ₹10,800 per quintal by the government. Retail packing price of the *guggul* gum, *babul* gum and *salai* was recorded as ₹1000/kg; ₹160/kg and ₹240/kg, respectively.

During the 2015-16, price of rosin and turpentine oil ranged from ₹ 60-86/kg and ₹ 79-80/litre, respectively (HPSFC Ltd.). Prices for different grades of rosin and turpentine oil were comparatively lower than the previous year rates.

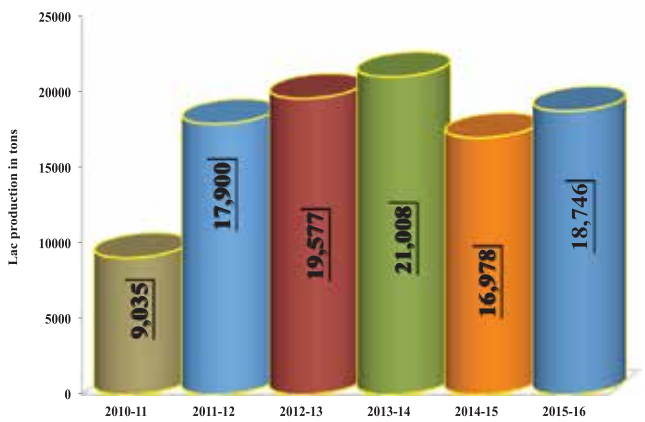


Fig. 72: Lac production in India during recent years

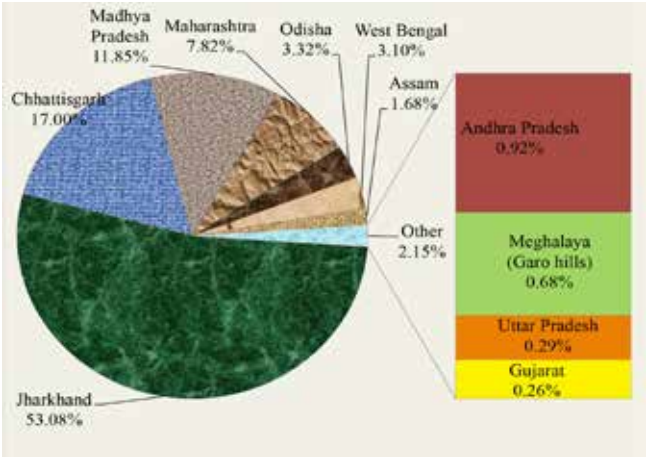


Fig. 73: State wise contribution in lac production

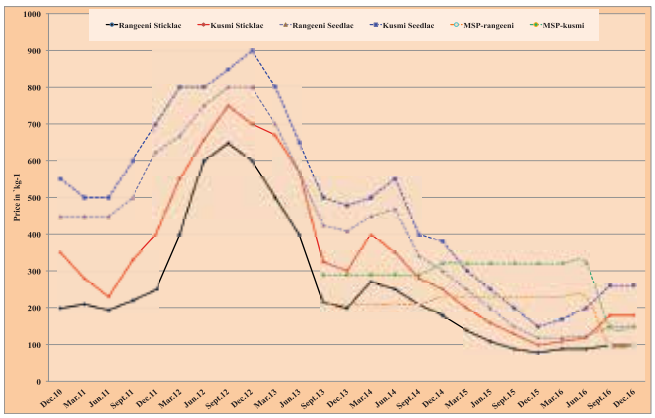


Fig. 74: Movement in prices of scraped lac and seed lac

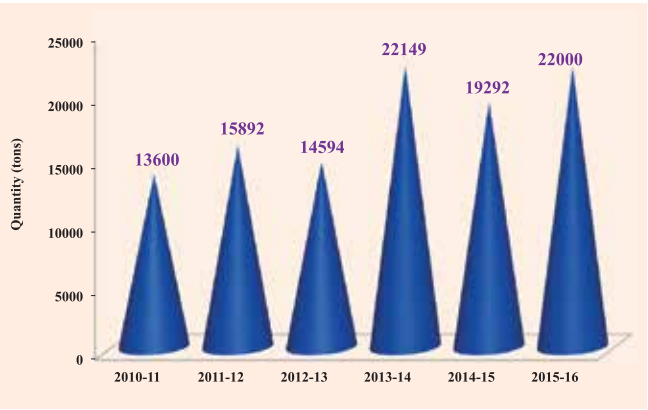


Fig. 75: Lac processing in India during previous seven years

Export price of aleuritic acid ranged from ₹ 9000/ kg in December 2012 to ₹ 2738/kg in December, 2015. In the subsequent quarters, price continuously declined and reached at very low level of ₹ 1600/kg in December, 2016. The exported quantity of the lac and lac based products has increased by 16.73% during 2015-16 over the previous year and it was valued about ₹ 24755.2 lakh (Figs 76a & 76b).

Similarly, price of Ambrettolide ranged from ₹ 20,000/ kg in July 2013 to ₹ 7898/kg in Dec, 2015. In December 2016, the average export price of Ambrettolide was observed at low level of ₹ 6600/kg.

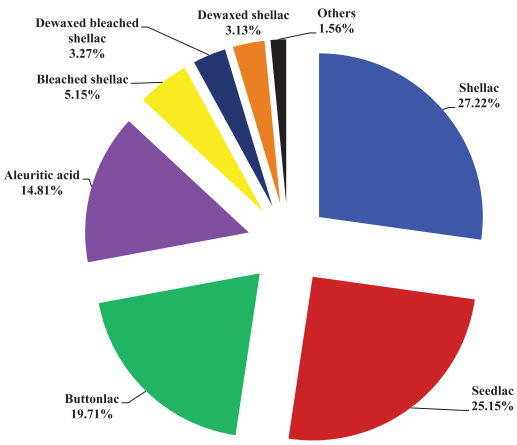


Fig. 76a: Composition in overseas demand of lac & its value added products

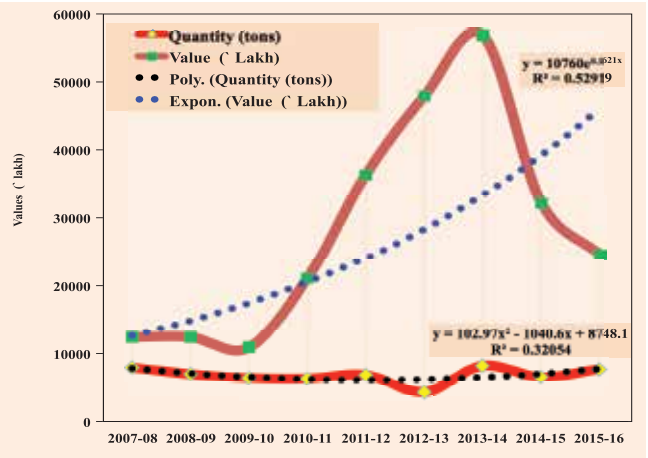


Fig. 76b: Trends in overseas demand of lac & its value added products

Aleuritic acid based industrial units are not getting normal profits at this level and incurring losses. International price of various grades of *guar* gum ranged from $ 1191/t to $ 3091/t during the year of 2015-16 (Fig. 77). Export of NRG showed a decrease in quantity as well as in value terms in 2015-16 comparatively during 2014-15. Consequently, the total value of NRG export particularly for *guar* gum was less than previous four years. Based on the final data available till November 2016, a decline in export is noted.

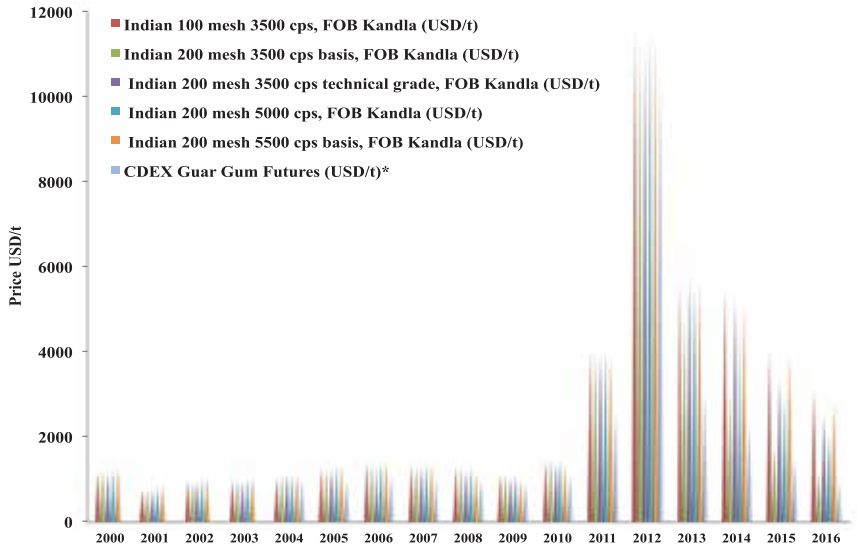


Fig. 77: International price level of different grades of *guar* gum during previous years

A perusal of the Table 17 about export trend of NRGs indicates a considerable variation in the mean export levels.

Table 17. Two way classification of NRGs [Compound Annual Growth Rate (15 Years)]

Category	Natural resins	Gums	Gum-resins
Negative	Mastic gum(MG), damar batu (DB) and Rosin lac Total natural resins (NR)	*Xanthun* gum (XM) African gum (AFG) *karaya* gum- Indian Tragacanth (KG IT)	Other gum resins (OGR)
Positive	Copal, Other natural resins (ONR)	Tragacanth (adracanth) Gum *arabic* (GA) and asian gum (AG) Other natural gums (ONG) *Guar* gum refined split (GGRS), *guar* gum treated & pulverized (GGTP) and total natural gums (NG)	Oilbanum or Frankincence, Myrrh, Asafoetida and total natural gum resins (NGR) Total NRGs

There are various factors which may explain the trend of the quantity exported. The pattern of the variation across the various commodities was studied. Deceleration in the exported quantity was ranged from 1% in dammar batu to 79% in *xanthum* gum. Overall, the export of NRGs was accelerated by 110% during the period. The overall compound annual growth rate (CAGR) in natural resins and gums exported from India showed positive and significant (10.69 %) growth. A significant and positive CAGR was observed in export of *Tragacanth* (adracanth) only. A negative and insignificant CAGR was observed in export of two natural resins namely mastic gum (MG) and damar batu (DB) during the period.

Instability index for exported quantity of total natural resins and gums classified across three categories of low (15-59), medium (60-118) and high (above 118) instability level (Fig. 78). Export of all the commodities under very low volume category *viz.* copal, mastic gum (MG), damar batu (DB), tragacanth (adracanth) and myrrh showed medium instability index. Similarly in low volume category, export of *xanthun* gum

(XG) and oilbanum or frankincence (OBF) were also indicated medium level instability. But, it is important to note that african gum (AFG), a low volume export commodity was facing the high instability over the period. Apparently, this figure of high instability may be alarming situation for the policy makers particularly for forest policy issues. Further, perusal of medium category in the Fig 78 is quite comfortable in the sense of instability in export of *asian* gum (AG), gum *arabic* (GA) and other gum resins (OGR). Lac, other natural gums (ONG), *karaya* gum (Indian Tragacanth) (KGIT), asafoetida and total natural gum resins (NGR) under high volume export category, were comparatively had a stable international market. In fact, two commodities in this group, lac and *karaya* gum have an institutional support, processing infrastructure and export promotional activities in India. However, for more international linkages a separate government board is required for minimizing the existing level of instability in both lac (15.27%) and *karaya* gum (22.83%). A medium level of instability in export of rosin and high level of instability in export of other natural resins (OR) was observed. Further, under very high volume export category, all the commodities *viz*. total natural resins (NR), *guar* gum refined split (GGRS), *guar* gum treated and pulverized (GGTP), total natural gums (NG) and total NRGs showed relatively low instability index. In medium category except rosin, copal and oilbanum, the instability indices of all the commodities ranged from 100 to 117. Simultaneously, it indicates the zero and negative level of stability. This group of commodities needs immediate support in international market to avoid the market volatility and bringing the stability in demand and supply.

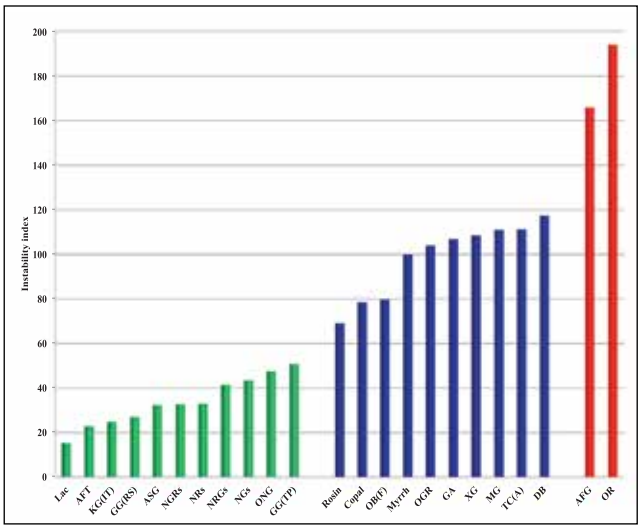


Fig. 78: Instability index of the various NRGs

Impact assessment of technological interventions

Under impact assessment studies, data has been compiled and analysed. Adoption of improved method of pruning, broodlac inoculation, *phunki* removal, pest management and post harvest management was increased. Analyses also indicated that farmers were acquainted with the advantages of scientific practices over conventional method. Impact of adoption level resulted as increased productivity level across various category of households. Price stabilization policy of the government is favourable policy intervention, but its execution at big level is needed with enough infrastructures for the procurement and disposal. Lac processing and marketing infrastructure related marketing issues were studied. Hurdles at primary level marketing were also identified.

6.2 Other extension activities undertaken by Transfer of Technology Division

Lac crop surveillance

To collect information on crop status and monitor the crop for rectification in technology, a total of 20 crop monitoring visits were conducted by the institute experts across the districts of Jharkhand, West Bengal, Chhattisgarh, Meghalaya and Assam (Appendix-V). The technological needs are transferred to collaborating institutions and farmers.

Participation in Exhibition/*Kisan Mela*

To create awareness and display the technologies developed by the ICAR-IINRG, Ranchi; the Institute participated in different Exhibition / *Kisan Mela* organized by different other agencies during 2016 and provide technical expertise on NRG to the stakeholders. Altogether Institute has participated in eight Exhibition/*Kisan Mela* and around 164000 beneficiaries got benefitted and aware about the technology of the Institute (Appendix-VI).

Kisan Gosthi/Workshop/FIG/Interface meetings

The institute has organized/participated *Kisan Gosthi*/ Workshop/FIG/Interface Meetings in collaboration with various institutions. A total of 12 such event was conducted and 2946 stakeholders of Jharkhand, West Bengal and New Delhi were benefited (Appendix-VII).

Field and method demonstration conducted

Five field demonstrations on scientific lac cultivation technologies and seven method demonstration on broodlac dipping in pesticides to preserve the crop from pest incidence were conducted at various places in Jharkhand, Bihar and West Bengal (Table 18).

Table 18. Field and method demonstrations conducted

Field demonstrations on scientific lac cultivation							
Sl. No.	**District/ State**	**Location/ Site**	**Technologies**	**No. of host plants**	**Crop**	**Input provided**	**Linkages**
1.	Banka, Bihar	Farmers Field (in group) in village Saliya	Winter season *Kusmi* lac on *ber*	30	*Aghani*, 2016-17	Broodlac- 50 kg & pesticides	Ramkrishna Vivekananda Seva Ashram, Deoghar
2.	Banka, Bihar	Farmers Field (in group) in village Kusumdih	Winter season *Kusmi* lac on *ber*	50	*Aghani*, 2016-17	Broodlac- 50 kg & pesticides	Ramkrishna Vivekananda Seva Ashram, Deoghar
3.	Khunti, Jharkhand	Farmers Field (in group) in Village- Siyankel & Ghanghari	Winter season *Kusmi* lac on *ber*	25	*Aghani*, 2016-17	Broodlac- 50 kg & pesticides	WOTA, Murhu,
4.	Khunti, Jharkhand	Farmers Field (in group) in Village- Manhatu, Torpa	Winter season *Kusmi* lac on *ber*	25	*Aghani*, 2016-17	Broodlac- 50 kg & pesticides	TRDS, Torpa, Khunti
5.	Ranchi, Jharkhand	Farmers Field (in group) in Village- Beradih	*Rangeeni* lac cultivation on *palas*	60	*Katki*, 2016	Broodlac- 60 kg & pesticides	Under MGMG programme

Method demonstrations conducted on treatment of broodlac by dipping method			
	Site of demonstration	**District**	**Collaborating Agency**
1.	Beradih, Namkum	Ranchi	Under MGMG programme
2.	Gutahatu, Murhu	Khunti	CINI (NGO), Jamshedpur
3.	Upper Dahu, Namkum	Ranchi	Lac grower
4.	Ashabani	Deoghar	CINI (NGO), Jamshedpur
5.	Kamed Moria	Dumka	CINI (NGO), Jamshedpur
6.	Ekra, Khatkadih and Bareria	Purulia	Lac grower
7.	Saraitola, Rampur, Namkum	Ranchi	Lac grower

Entrepreneurship development - Technology adoption by entrepreneurs

An entrepreneur from Sakti, Chhattisgarh started production of 2.5 tons of bleached lac/month and one younger entrepreneur started production of 2.0 tons of aleuritic acid at M/s KD Udyog, Nadia, West Bengal after receiving training from this Institute.

Model Training Course

A Model Training Course on Natural Resins and Gums: Agribusiness Modules for Skill & Entrepreneurs Development organised during September 2-9, 2016 at ICAR-IINRG, Ranchi sponsored by Directorate of Extension, Deptt. of Agriculture, Co-operation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi. A total of 23 stakeholders participated under this skill oriented course.

Resource generation

Training and Consultancy : A sum of Rs. 13.948 lakh was generated through training charges, consultancy project and sale of literature during the period.

Promotion of lac based handicrafts : Lac based handicrafts of worth Rs. 8,516 sold during the period.

Liaisoning with lac processing industry and Technical guidance/Advisory

Liasioning with lac processing units situated in Jharkhand, Chhattisgarh and West Bengal has been strengthened through visits and interactions. Technical guidance and advisory were given to different institutions/stakeholders from industry (Table 19).

Table 19. Details of technical guidance and advisory (industry)

Sl. No.	Stakeholder	Nature of Advisory
1.	TRIFED, New Delhi	Fixation of MSP of lac and *Karaya* Gum based on cost of production/ Collection
2.	Ankiit Shellac Factory, Balrampur	Aleuritic Acid
3.	Anurag Nilesh Soy, Hulhundu, Ranchi	Lac-based Varnishes
4.	Kalicharan Machhuwa, Bundu, Ranchi	Gasket Shellac Cement Compound
5.	Vivek Agarwal, Khunti	Aleuritic acid, Gummy mass and Isoambrettolide
6.	Krishnendu Dutta, M/s K D Udyog 24-Parganas (WB)	Purification of aleuritic acid, removal of wax
7.	Roshan Tirkey, Bano, Simdega	Aleuritic acid, Bleached lac
8.	Deepak Kumar, M/s Aadhya International, Mumbai	Lac-based Varnishes, Dewaxed Decolourized Lac and Kinnow Fruit Coating Formulation

6.3 Externally Funded/Consultancy Projects

Lac (Culture) Cultivation and Processing Unit Establishment

In its final stage of the project and positive feedback from the stakeholders, a small scale lac processing unit was established at Murhu block of Khunti. A Research –Extension-Farmer's Interface-cum-Workshop on Lac Cultivation at Torpa, an exposure visit for 86 beneficiaries of Murhu and Rania block in Exhibition-cum-*Kisan Mela* 2016 at ICAR-IINRG, JASCOLAMPF and *Saras Mela* Ranchi was conducted. An awareness programme on lac cultivation on *F. semialata* was conducted at Korakel panchayat. Besides, other extension activities mainly many field level activities were organized. Lac handicrafts stall was put up during NRLM women's rally at Nehru Stadium Ranchi.

Evaluation of lac cultivation processing activities in Chhattisgarh under Swarnjayanti Gram *Swarozgar Yojana* (SGSY) Special Project (Phase- II)

In Second Phase, to evaluate the project entitled, Lac Cultivation Processing in all District of Chhattisgarh CGMFP (Chhattisgarh State Minor Forest Produce Ltd.), Raipur, at the instance of and as per the guidelines of SGSY constituted an evaluation committee to assess the impact of Centrally Sponsored Schemes in selected 19 lac growing forest divisions of Chhattisgarh State and sanctioned ₹5.7 lakh as consultancy charges at the rate of ₹0.3 lakh/project. The objectives of the study were to examine whether selected SHGs across the various districts have generated the desired benefits or not. If not then, specify reasons for their tardy implementation, shortcomings in implementation and steps required to tone up their implementation, including their monitoring, to achieve the desired results. The efforts made by the experts through surveys, SHG meetings, interviews with beneficiaries, field visits and discussion with the local village authorities and stakeholders across the six districts. The study entitled, 'Impact assessment of the technology, market and infrastructure based interventions by CGMFP under the SGSY' conducted during 2015-16. Members of identified SHGs and other concerned personnel were interviewed regarding the various aspects of lac cultivation and its disposal. Market value of the produce was transferred in the bank accounts of SHG members. For this, the proof of money transfer was checked in bank passbooks of concerned beneficiaries of the SHGs. The data compilation and analysis is under progress.

NEH Sub-plan

A small scale lac processing unit was established in Chirang district of Assam to demonstrate the lac processing technology in NEH region and a total of 400 kg broodlac was distributed in Chirang district (facilitated by Aie Valley Lac Producer & Allied Agro Marketing Co-operative Society Ltd.). A training programme of 24 beneficiaries from Chirang district was organized during 16-21 May 2016 at ICAR-IINRG, Ranchi. Seed of *Flemingia macrophylla* (500 g) was distributed in Meghalaya for introduction of lac cultivation on this (facilitated by MIE, Shillong).

6.4 Success Stories

Transforming Livelihood of Tribal Farmers in Assam through *kusmi* lac cultivation on *ber* (*Ziziphus mauritiana*)

Dhemaji district of Assam has a huge chunk of Other Backward Classes (OBC) population comprising of Ahoms, Chutiyas, Konches, etc. The Schedule Tribes include Mishings, Sonowal Kacharis Bodos, Deoris, Lalungs, Hazongs, etc. The general geochemical characteristic of the soil is highly acidic. However, new alluvial soils formed due to inundation of land by river at intervals contain more percentages of fine sand, fine silt and are less acidic. The soils of this district can be broadly classified into three different zones. The foothill soils, active flood plain soils near the river Brahmaputra and the low-lying marshy lands. Deep, well drained, loamy sand/sandy loam soils occurring on very gently sloping flood plain, having loamy surface with moderate erosion and moderate flood hazard. In this backdrop, the need of an additional source of income generation was realized in the area. Subsequently, Mising Autonomous Council (MAC) came into forward which was established under the Mising Autonomous Council Act, 1995. Dr Ranoj Pegu, Chief Executive Councilor MAC, Dhemaji has taken keen interest for this issue and noticed the large number of *ber* trees. He approached ICAR-IINRG, Ranchi for the economic use of available *ber* trees. Consequently, ICAR-IINRG planned, designed and executed the scientific interventions through lac cultivation activities since 2014-15. At various platforms, discussion was made with the local representatives, farmers, processors/manufactures/ wholesalers, traders, experts and other concerned officials to promote the lac cultivation activities in the newer areas.

The knowledge of farmers on scientific lac cultivation on *ber* trees and livelihood improvement through the use of available *ber* trees were taken up through series of capacity building programmes like workshops, training, field demonstration, exposure visits and interactive session for feedback. As lac cultivation is a labour intensive activity, MAC was able to initiated pruning process in July, 2014. Due to suitable climatic condition tender shoots were ready for inoculation in January 2015 and 10 quintal *kusmi* broodlac was inoculated on 3000 *ber* trees at various places of Dhemaji and Chirang district of Assam. Simultaneously, about 5000 lac host trees were pruned.

Subsequently, teams of the experts were executed crop monitoring and provided as a technical support, diagnostic services were also provided. Various activities like baseline survey of potential areas, the selection of trees at the site, training and technical guidance, exposure visits, pruning, backward market linkages for broodlac and pesticide supply, selection of broodlac, bundling of broodlac, broodlac treatment through dipping method, timely inoculation, *phunki* removal, forward market linkages for disposal of the output, spraying, harvesting and scraping or self inoculation were introduced among the stakeholders. These interventions brought confidence among the resource poor tribal farmers in lac cultivation during 2015-16 in a sequence of *jethwi* (January-February to June-July) and *aghani* crop (June-July to January-February) instead of wandering here & there without employment in locality. The yield of *jethwi* was higher than *aghani* crop. Further introduction of dipping treatment of broodlac during *agahni* crop, enhanced yield by 28% with saving of the cost of nylon net 32%, which resulted in improvement in productivity by 60% compared to previous crops.

In July 2015 the *jethwi* crop was harvested with a very low production due to delayed inoculation and mortality of broodlac during transportation and self inoculation was done on survived *ber* trees for next *aghani* crop.

In February, 2016, the *aghani* crop was harvested with a production of very low level and inoculation (10 qt broodlac from Joydeb Mahato, Purulia) was done on 5000 *ber* trees for next *jethwi* crop. In July, 2016 the *jethwi* crop was harvested with a production of 60-70 qt broodlac and 20 qt used for inoculation on 7000 pruned ber trees for next *aghani* crop. Here, the crop cycle could not continue, even though, they got good harvest for this season and have tested the profit.

In December 2016, about 7 qt scraped lac loaded for market at Balarampur at the rate of Rs. 180-200/Kg as told by the Mr Shekhar. The management of available resource base through new intervention in tribal areas enabled them to harvest a good crop without affecting other activities. Low input based lac culture may be promising activity for additional income. Through capacity building programmes, farmers were exposed to various modern management practices and were trained about the package of practices of lac cultivation activities; care and maintenance of broodlac in new systems. The interventions added average annual Rs 5.0 lakh to Rs 8.0 lakh during 2015-16 and 2016-17. Enthused with the results, the *Bodoland* Territorial *Council* (BTC) and The *Karbi Anglong Autonomous Council* (KAAC), other councils and TRIFED showed the interest for interventions through scientific lac cultivation activities during 2016-17.

About 100 farmers during the workshop on *Kusmi* Lac Cultivation in MAC Areas and Feedback from Lac growers and further management practices were benefitted. About 50 farmers were interacted during field demonstrations at various places near the river Brahmaputra and other major tributaries like Nalbari (1), Muskua (1) of Dhemaji district (Assam) and 50 social workers/local representative, KVK officials, scientists of ARS of AAU, Lakimpur and officials of MAC working at grass root level from various areas of Assam were interacted. Scientific lac cultivation activities were introduced in the tributaries area of river Brahmaputra to utilize the broodlac carrying capacity of existing lac host trees. This has resulted in enhanced income in the partner villages as compared to pre-intervention period.

During 2015 and 2016 one thousand *ber* trees each were inoculated with *kusmi* broodlac in both the seasons and lac produced ranged from 2100 to 3000 kg.

Value addition enhanced the profit of lac manufacturer through technological interventions

Sri Vivek Jaiswal's keenness to learn and innovate coupled with his hard work has enabled him to set new landmarks in production of aleuritic acid, a value added product isolated from lac resin and mainly used in perfumery industry to develop musk-based perfumes. 'Our grandparents, in search of livelihood, migrated to Balarampur in Purulia district of West Bengal from Mirzapur in Uttar Pradesh more than a century ago when lac cultivation was discontinued in the area due to crop failure and factories for the preparation of shellac from stick-lac were closed', said Vivek. Earlier he was manufacturing only semi-refined traditional products-seedlac and shellac. Upon learning that most of the lac is exported to Europe and US in the raw form, I thought to do some value addition instead of selling the raw seedlac, said

Breaking-off of lumps of pre-dried aleuritic acid

Vivek (32 years old and a graduate in science) In the year 2010, he came across certain new innovative methods for manufacturing of aleuritic acid from lac resin published in the Natural Resins and Gums News Letter of IINRG, Ranchi. This made me think for doing something innovative rather than washing and selling raw seedlac and shellac, said Vivek. He took training on manufacturing of aleuritic acid on pilot plant scale organized by the Institute in November, 2010.

Initially, Sri Jaiswal established aleuritic acid manufacturing plant with one filter press using the

Drying of aleuritic acid in trays under controlled atmosphere

new technique developed by ICAR-IINRG. While this plant started giving him decent profits, he added two more filtering units and started manufacturing 3.0 tons of aleuritic acid per month. He said that from aleuritic acid plant with three filter units, he earned net profit of Rs. 24 lakhs per month. Now seeing the better prospect in value-added lac product he has completely shifted to producing aleuritic acid from seed lac. Besides consuming all the seed lac produced by his plant, he is also procuring seed lac from others to manufacture aleuritic acid for higher profits. His profit margin has increased by more than 1.75 times by shifting from seed lac to manufacturing of aleuritic acid.

Network Projects

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

1.1 Lead Centre: ICAR-Indian Institute of Natural Resins and Gums, Ranchi

Development and antibacterial activity of *Buchanania lanzan* (*Piyar*) gum-based silver nanoparticles

The green synthesis of silver nanoparticles (AgNPs) of *Buchanania lanzan* (commonly known as *char, achar, piyar*) gum exudates, collected from Bilaspur (Chhattisgarh) (G11) was carried out by autoclaving the reactants (varying concentration of aqueous extract of gum and 1mM silver nitrate solution), at 121^{0}C and 15 psi. The synthesis of silver nanoparticles was monitored by UV-Vis spectra at 200 -700 nm against the autoclaved blank gum solution. In UV-Vis spectra, strong peaks with maxima around 418-430 nm were observed which correspond to the typical Surface Plasmon Resonance (SPR) of conducting electrons from the surface of silver nanoparticles and which increases with the increasing gum-concentration up to 3.0%, confirming an enhancement in the nanoparticle synthesis. The synthesized and lyophilized piyar gum-based AgNPs were characterized by UV-Vis Spectroscopy, FT-IR Spectroscopy, Particle Size Analysis, Zeta Potential, and SEM-EDX. Morphological features of the *piyar* gum and its synthesized silver nanoparticles (AgNPs) using 0.5 % and 3.0 % gum concentrations were studied with a JEOL JSM-6390 LV Scanning Electron Microscope.

In FT-IR spectra, the disappearance of broad band at 2144 cm^{-1} (due to various carbonyl groups of gum) at 3.0% gum-concentration confirms that the reduction of the silver ions is coupled to the oxidation of the hydroxyl and carbonyl groups of the gum (Fig.79a). Further, shifts in the absorbance peaks from 3309 to 3329 cm^{-1} (due to stretching vibrations of O–H groups), 1600 to1604 cm^{-1} (due to characteristic asymmetrical stretch of carboxylate group) and 1373 to 1384 cm^{-1} (due to symmetrical stretch of carboxylate group) with decreased band intensity is suggestive of the binding of silver ions with hydroxyl and carboxylate groups, respectively.

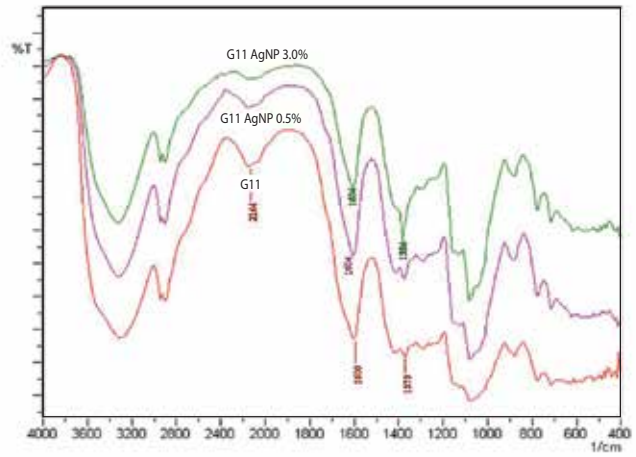


Fig. 79a: Characterization of synthesized *piyar* gum-based AgNPs by FT-IR spectroscopy

Energy Dispersive X-ray Analysis (EDX) equipped with SEM, clearly showed the presence of elemental Ag peak along with Ca, Mg & Pt, confirming the incorporation of Ag in the synthesized nanoparticles (Fig. 79 b)

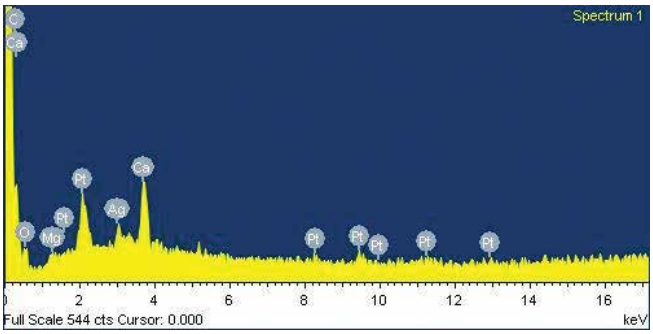


Fig. 79 b: EDX spectrum of *piyar* gum-based AgNPs

Z-average hydrodynamic diameter of AgNPs was determined using Dynamic Light Scattering (DLS) technique (Malvern, Nano ZS) at a scattering angle of 173^0. The synthesized piyar gum-based AgNPs with 0.5% gum concentration showed zeta potential value -19.8 mV & Z-average 176.0 (d.nm) whereas with 3.0 % gum concentration, zeta potential value obtained was -19.1 mV & Z-average 329.1 (d.nm). Polydispersity index (PDI) with 0.5% and 3.0% gum concentrations was found to be 0.288 and 0.577 respectively, indicated that the particles are in monodispersed phase with very low chances of aggregation

For studying morphological features, the images were taken at an accelerating voltage of 10 KV and

at different magnifications. The most meaningful information was obtained at X500 (Fig. 80) and X2000 magnifications and 50 µm and 10 µm scales and found that the gum has tiny, distinct, irregular, elongated large particles size. On the contrary, the *piyar* gum-based AgNPs's surface morphology showed quite distinct inter-woven net like structures

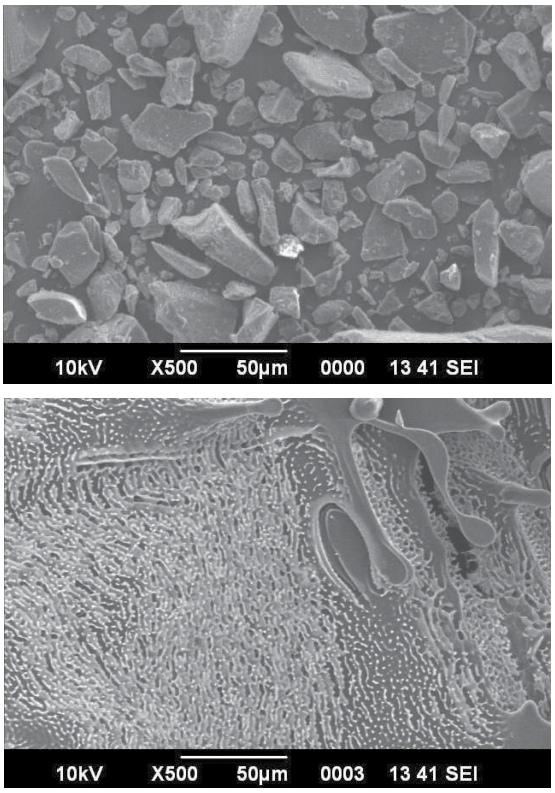


Fig. 80: SEM image of unreacted and synthesized *piyar* gum based AgNPs (magnification 500X)

Field guide for identification of major resin and gum producing plants

To prepare photographic catalog of common resin and gum producing trees, several field visits were conducted. During these field visits various gum and resin producing trees were identified, their different parts such as leaves, flowers, fruits, seeds, bark, gum exudates, etc. were photographed and documented. The photographs of the different plant parts of about 28 major gum-resin producing trees including Pine (*Pinus roxburghii, Pinus wallichiana, Pinus kesiya*), Dammar (*Shorea robusta, S. talura*), *Babool* (*Acacia nilotica*), *Acacia leucophloea, Acacia chundra*, *Khair* (*Acacia catechu*), *Acacia fernaciana, Acacia mollisima, Acacia senegal, Acacia mellifera, Prosopis juliflora, Albizzia stipulata*, *Palas* (*Butea monosperma*), *Karaya* (*Sterculia urens*), *Ghatti* (*Anogeissus latifolia*), *Jhingan* (*Lannea coromandelica*), Neem (*Azadirachta indica*), *Moringa oleifera*, *Salai* (*Boswellia serrata*), *Guggul* (*Commiphora wightii*), *Piyar* (*Buchanania lanzan*) (Fig. 81), *Guar* (*Cyamopsis tetragonolobus*), *Okra* (*Abelmoschus esculentus*), *Cassia tora*, Tamarind (*Tamarindus indica*) etc. were taken. Efforts to get more photographs of season specific plant parts are being made in order to cover various gum and resin producing trees with their different parts.

Fig. 81: Different plant parts of the *piyar* tree (*Buchanania lanzan*)

1.2 Project on gum *Arabic* at ICAR-CAZRI, Jodhpur

Extension and adoption of gum inducing technique

The technology of exudation of gum *Arabic* and other types of gum through CAZRI gum inducer has been well established. It has spread far and wide in arid Western Rajasthan and as well as in other

parts of the state. In addition to Rajasthan state, stakeholders from Haryana, Gujarat, Madhya Pradesh and Maharashtra have shown keen interest on gum exudation technology of CAZRI. Farmers' are earning good amount of money by way of sale of gum Arabic in local market of arid western Rajasthan. Since the inception of present network project the rate of adoption of the technology is increasing year by year.

In more than 45 villages, farmers of Chauhatan and Baytu tehsils of Barmer district; Shergarh and Phalodi tehsils of Jodhpur district; and some villages of Nagaur and Pali districts have adopted the gum inducing technology in large scale. During the period under report total number of 19500 *A. senegal* trees were treated by CAZRI gum inducer, resulting in production of approximately 7.80 t of gum *Arabic*. This year the average rate of gum *Arabic* was Rs. 800/- per kg in local market. Thus, farmers of said villages earned revenue of Rs. 62.40 lacs (Table 20).

On 15th March, 2016, a one-day Farmer-scientist interaction meeting was organized at Bawarly-bambore village cluster, Jodhpur under *MGMG* Programme. During the programme, farmers shared information about gum exudation technology (Fig. 82). Gum exudation training for technical staff of ICAR-CAZRI, RRS, Jaisalmer was organized on 16th April, 2016 as also demonstration-cum-training of gum exudation technology at KVK, Jaisalmer.

Table 20. Gum *arabic* production and economic returns in 45 target villages of Barmer, Jodhpur and Nagaur district of arid western Rajasthan

Particular	Year								Total
	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	
Number of A. *senegal* trees treated (in thousands)	12.1	20.95	22.61	27.5	30.00	34.17	20.70	19.50	187.53
Production of gum *arabic* by farmers (t)	5.45	10.48	7.67	11.00	12.00	13.67	8.28	7.80	76.35
Total income earned by farmers (Rs. Lakhs)	27.23	52.38	38.33	77.00	84.00	95.69	57.96	62.40	487.19
Revenue generated by CAZRI (Rs. Lakhs)	1.21	2.10	2.25	2.75	3.00	3.42	2.07	1.95	18.75

Fig. 82: Farmer-scientist interaction meeting organized at village Bawarly-Bambore, Jodhpur on 15th March, 2016

Effect of management practices and gum inducer on gum production of *Acacia senegal* in rocky and semi-rocky lands

Experiments were continued during the year 2015-16 at Bhopalgarh experimental area of ICAR-CAZRI, Jodhpur. Treatments comprised of 2 factors. Factor one consisted of 3 levels of management practices *viz*., irrigation, manuring and irrigation + manuring with an absolute control. Factor 2 consisted of 2 concentrations of gum inducer *viz*., half concentration of normal dose (2 ml) and normal dose (4ml) with an absolute control. Normal dose of 4ml contains 780 mg ethephon/ 4ml of solution.

The results of six years experimentation are set in Fig. 83. In case of control (conventional practice making blazes on tree trunk) the gum production was more or less negligible. However, fortnightly two irrigations before treatment during 2015-16 resulted in production of gum to the tune of 56.00 g/tree in case of half concentration of the normal dose treatment. In case of control (normal dose only), 60.0 g/tree gum was harvested. Only manuring of

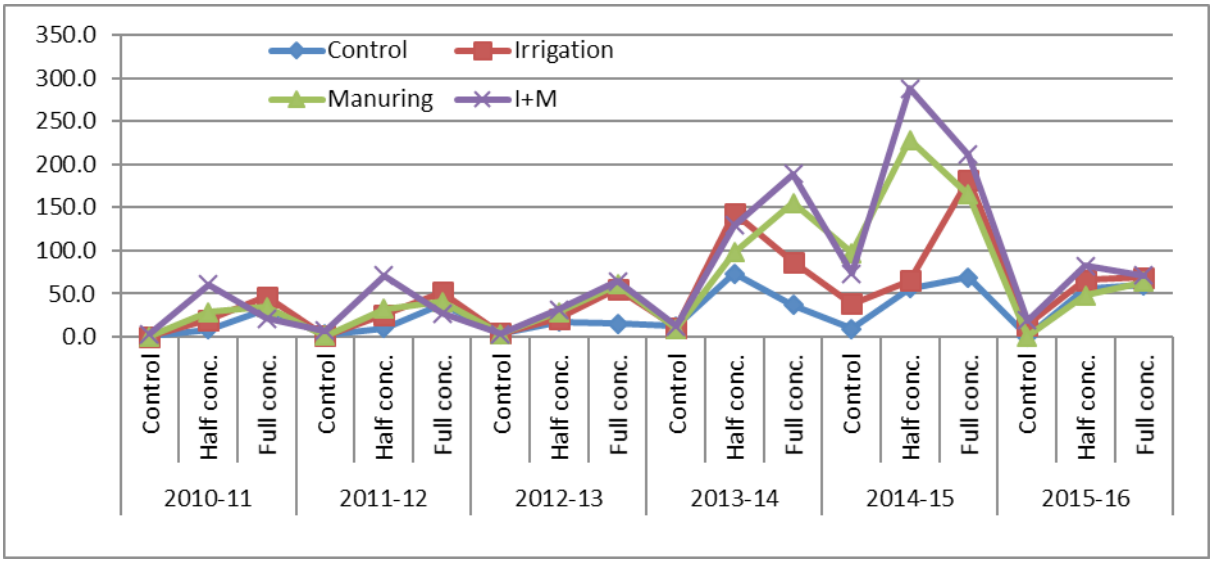


Fig. 83: Gum yield (g) with different levels of concentration of gum inducer and management practices at rocky and semi-rocky range land of Bhopalgarh.

the trees resulted in production of 48.00 and 64.00 g gum/tree in half concentration of normal dose treatment and full concentration, respectively. Full concentration of CAZRI gum inducer + irrigation + manuring resulted in production of gum *arabic* to the tune of 71.00 g/ tree and in case of half concentration of gum inducer + irrigation + manuring resulted in production of gum to the tune of 82 g/tree. This clearly indicated that with little tree management in form manuring and watering with gum inducer application, substantial increase in yield is possible. In rocky and semi- rocky areas where *A. senegal* grows in abundance, tree management practices coupled with gum inducer application can be effective for gum *arabic* exudation. As already stated that about 23,520 sq km area in arid western Rajasthan is rocky and semi-rocky and *A. senegal* is main tree constituent of such land formation. In case of 30 trees/ha, such unproductive land form can produce 5-6 kg gum/ha, which can provide an additional income of Rs. 3500-4200/- to the farmers. In addition, Rs. 2000 to 3,000 could be earned by sale of *Acacia senegal* seeds from the same plantation.

Plantation of high gum yielding plant type of *A. senegal*

A stand of high gum yielding plant type of *A. senegal* (Nigerian origin) was established on CR farm of ICAR-CAZRI during monsoon season of 2010. The survival percentage after 6 years was more than 96%. The row to row and plant to plant distance is 3 x 3 m. On an average plant attained a height of 3.08 m and, collar diameter (CD) 19.01 cm and canopy diameter 2.66 m (Table 21 & Fig. 84). This year gum exudation trial was conducted first time. Fifteen trees having more or less similar color diameter were injected by CAZRI gum inducer. Average gum yield/ tree obtained was 95 g with a range of 75-123 g.

Table 21. Height (cm) and girth (cm) of the high gum yielding Nigerian plant type of *A. senegal*

Height (m)										
Row-1	Row-2	Row-3	Row-4	Row-5	Row-6	Row-7	Row-8	Row-9	Row-10	Avg.
2.85	2.90	2.60	3.15	3.29	3.19	3.25	2.91	3.27	3.39	3.08
DBH (cm)										
14.86	16.56	17.64	20.36	22.84	18.95	20.11	18.22	17.87	22.60	19.01
Canopy Diameter (m)										
2.43	2.29	2.39	2.98	3.24	2.93	2.79	2.48	2.39	2.71	2.66

Fig. 84: Six years old plantation of high gum yielding Nigerian plant type of *A. senegal*

Gum exudation trial on lesser known trees at Jaisalmer

During current year two identified lesser known gum trees (*Cordia gharaf* and *A. jacquemontii*) were treated with CAZRI gum inducer at ICAR-CAZRI, RRS, Jaisalmer research farm because good population of these species were present there. Eleven trees of each species were treated. Structural traits and gum yield were recorded (Fig. 85). Data indicated that in case of *C. gharaf,* the average gum yield was 166.7 g/tree and in case of *A. jacquemontii,* the average yield was 32g/tree. The gum of both tree species (Fig. 86) is used by the villager for edible purpose.

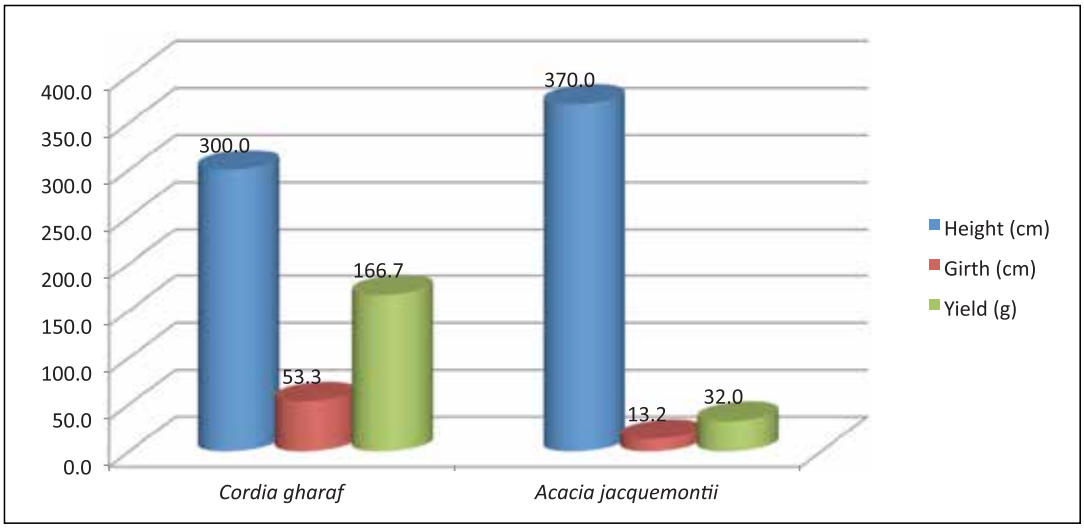


Fig. 85: Gum exudates trials of various tree species at ICAR-CAZRI, RRS, Jaisalmer

Fig. 86: Gum exuded from *A. jacquemontii* and *Cordia gharaf* at ICAR-CAZRI, RRS, Jaisalmer

Gum exudation trial in cold arid region of Leh

During this year, gum exudation trials were carried out in cold arid regions of Leh district. With the help of ICAR-CAZRI, RRS, Leh randomly selected trees *viz*. *Eleagnus agustifolia* and *Prunus armenica* were treated with CAZRI gum inducer at Nimoo village of Leh district. Tree structure traits and gum yield recorded acordingly (Table 22). Gum exudation from *P. armenica* & *E. agustifolia* is presented in Fig. 87.

Table 22. Gum exudation trial in cold arid region, Leh

Tree species	Common name	Height (cm)	Girth (cm)	Average yield (g)
E. agustifolia	Sarsing	204.3	140.2	56.0
P. armenica	Appricot	365.8	176.8	145.0

Fig. 87: Gum exudation from *Prunus armenica* & *Eleagnus agustifolia*

1.3 Project centre at ICAR-CAFRI, Jhansi

Agro-forestry models

Development of agro-forestry models

From the analysis of data, obtained by monitoring the survival and plant growth in Agro-forestry models (6 years old) raised on CAFRI farm, following conclusions were drawn:

In agri-horti-silviculture model maximum survival and plant height was recorded in *Acacia senegal* while minimum survival and growth in *Carrisa carandus*. During the year, 20 kg of lemon fruits were harvested from 20 plants (total 24 citrus plants) and maximum fruits were found in East and minimum in the West. The order of number of fruits /plant was: East-113>North-80>South-62>West-55. The size of lemon fruit varied from 10g to 52g with average value of 28g (Fig. 88).

Fig. 88: Fruit yield from citrus plants at agri-horti-silviculture model

During Rabi season wheat (HUW 234 Z-1) was sown in agri-horti-silviculture model and plant growth and yield attributes were measured at different distances *viz*., 1.0m, 2.5m and 4.5m distances from each tree line (*Acacia senegal, Aegle marmelos* and *Citrus limon*) and control. Different tree species significantly reduced grain yield up to 1.0m distance from tree trunk while yield at 2.5m and 4.5m distance was not affected. Maximum total biomass was recorded under *A. marmelos*, however the grain yield was not affected.

During summer season (2015) natural oozing of gum in *A. senegal* (Fig. 89) and *A. nilotica* were observed in agri-horti-silviculture and horti-silviculture –II models. The gum yield of *A. senegal* ranged from 26.10 g/tree to 134.71 g/tree with an average value of 58.70 g/tree.

Fig. 89: Natural oozing of gum in *Acacia senegal*

In horti-silviculture–II model, *A. nilotica* has shown maximum growth. Survival of *A. senegal* in block plantation on rocky site was 100% and plants attained mean height of 430.40 cm with GBH (girth at breast height) of 17.10 cm. In general, survival and growth of *A. nilotica* was better than *A. senegal*. The gum yield of *A. nilotica* ranged between 11.66 to 90.63 g/ tree, with an average of 40.15 g/ tree.

In agri-silvi model (Field No. 40 and 41), after 3 years of plantation, on an average, *A. nilotica* (5 X 5 m spacing) has shown better survival and growth than *A. senegal* (10 X 5 m spacing)

Different agroforestry models at farmers' field in Garhkundar- Dabar (GKD) –(Bundelkhand region) watershed and Ambabai village

After 6 years of planting, *A. senegal* recorded more survival (78%) than *A. nilotica* (53%) in GKD watershed. Out of planted horti-cultural species, guava had shown maximum survival (98%) while, karonda the least (12%). Anola recorded maximum GBH and plant height. In terms of plant height *A. senegal* was better than *A. nilotica*.

Average survival percentage of *A. senegal* on field bunds ranged from 50 to 83% in GKD watershed.

In Ambabai village after 4 years of planting, survival of *A. senegal* was 54% with plant height of 254.90 cm and collar diameter 6.90 cm.

Gum garden

A gum garden of *A. senegal* was developed in July 2014, which is further extended in 2015 at Central Research Farm of CAFRI, Jhansi. In all total 353 plants of *A. senegal* and *B. monosperma* (as border row plantation) have been planted at 3 x 3 m spacing. In gum garden part I and II, the survival percentage of *A. senegal* (88 and 85% respectively) was better than *B. monosperma* (15 and 42% respectively).

Growth of *Anogeissus pendula* plantation

Monitoring of plantation of *Anogeissus pendula* and *Anogeissus latifolia*, established in 1990 with 5 x 5 m spacing, concluded that after 25 years of plantation better survival (89%) was recorded in *A. pendula* while, better GBH, canopy spread and height was observed in *A. latifolia*. This model is now being used as agroforestry models (Field No. 33 and 34) for tapping gum and raising intercrops. Another plantation of tissue culture raised progenies of 5 plus trees of *A. pendula* (1994), which is now used for standardizing gum tapping techniques, was monitored. The maximum GBH was recorded by AP-35 progeny while minimum by AP-12.

Standardization of gum tapping techniques

A field trial in February 2016 was conducted on naturally occurring 15-20 years old trees of *B. monosperma* to find out the effect of depth of incision on stem of tree for standardization of gum tapping techniques. Length of notching was studied on the stem bark of 20-25 years old tree. To regulate depth and length of cuts, a bill hook was purposely designed and got fabricated locally. The field trial consisted of three depths of cut *viz*. 0.5 cm, 1.0 cm and 1.5 cm and three lengths of cut *viz*. 1.0 cm, 2.0 cm and 3.0 cm

Maximum and minimum *B. monosperma* gum was obtained when notching was done up to 1.0 cm and 0.5 cm of depth on stem bark of the trees respectively

For analysing effect of length of cut on gum exudation, the depth of cut was kept uniform (1cm) for all trials. Findings revealed that maximum gum was obtained when length of incision was 1.0 cm followed by 3cm long notch. The 2.0 cm long notch yielded minimum *B. monosperma* gum (Fig. 90).

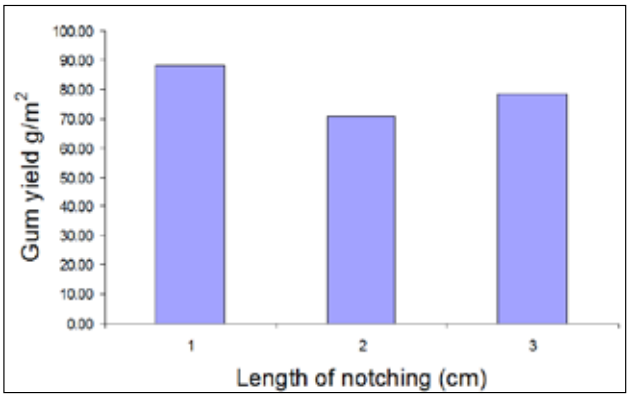


Fig. 90: Effect of different lengths of incision on stem bark on *B. monosperma* gum yield

Factors of survival of lac insect on *B. monosperma* in summer

In the year 2015-16, observations were recorded on temperature, relative humidity and survival of lac insect to assess critical levels of temperature and humidity for survival of lac insect on *B. monosperma* trees. Monitoring of lac survival started from 9 March, 2015 and ended on 27 July, 2015. About 48% lac insect survived during summer of 2015 which is better than the survival assessed in summer season of 2014 (complete mortality in second week of June).

1.4 Project on Guar Gum at VNMKV, Parbhani

In formulation of value added products, both *guar* and *arabic* gum plays an important role as stabilizer, emulsifier, texturing agent, thickening agent etc. depending upon the requirement. If a gum is used in combination with other gum/gums, the performance of each gum can be improved depending upon the selectivity of a particular property (fat reduction, texture enhancement etc.) of each gum during process of product development. Both *guar* and *arabic* gum are non-toxic, water soluble, contains nutritional values and can be used as dietary fibre. Hence, both can be added together, as gum blend, in food product formulation. Both *guar* and *arabic* gum were taken in equal proportion for making gum blend. Following products were developed using gum blend:

Preparation of millet nutri bar

Finger millet or ragi (*Eleusine coracana* L), amaranth (*Amaranthus cruentus*), bajra, (*Pennisetum glaucum*), green soya bean (*Glycine max*), jaggery, glucose and gum blend were used in formulation of millet nutri bar (Fig. 91). Gum blend was used in concentration of 0.0, 0.1, 0.2, 0.4 and 0.6 %.

The data pertaining to nutritive value of multi millet nutri bar (per 100g) was found to be as: fat 1.85 g, protein 4.66g, fiber 8.3g and energy 378 Kcal. Production cost of millet nutri bar was worked out on the basis of cost of raw material including processing and packaging cost. The total production cost for preparation of 100g multi millet nutri bar costs Rs 6 approximately. From sensory evaluation (using 9-point hedonic scale) of multi millet nutri bar, incorporation of 0.4 per cent of gum blend was found to be overall acceptable and it improved the texture of millet nutri bar. Shelf life of millet nutri bar was 90 days at room temperature.

Fig. 91: Sample of multi millet nutri bar

Preparation of peanut *chikki*

Peanut *chikki* (Fig. 92) was prepared using roasted peanut, sugar, liquid glucose and gum blend. Blend was used in concentration of 0.0, 0.1, 0.2, 0.3 and 0.4 %. The sample containing 0.3 % of gum blend was found to be overall acceptable with enhanced texture.

The force required to break the peanut *chikki* was ranged in between 12.98 Kg to 14.60 Kg. As the level (0.1, 0.2, 0.3 and 0.4%) of gum increased the force required was found to be decreased. As per the sensory evaluation, 13.48 kg force, for 0.3% gum blend, was found to be suitable *i.e.* satisfactory texture (bite).

Shelf life of peanut *chikki* was found to be 60 days under normal conditions. The production cost of 100 g peanut *chikky* was found to be Rs 5.52.

Fig. 92: Sample of peanut *chikki*

1.5 Project on Rosin at Dr. YSPUH & F, Solan

Standardization of resin tapping from *Pinus roxburghii* tree

The experiment on standardization of stimulants for borehole and rill method of resin tapping was carried out in natural stand of chir pine located at the University Campus, Solan. There were 4 treatments and each treatment had three replications. A replication comprised of five trees. The detail of the treatments is given below:

T_1: HCl 10% + 10% ethephon

T_2: H_2SO_4 10% + 10% ethephon

T_3: H_2SO_4 20% + 20% ethephon

T_4: HCl 10% + 10% ethephon

Bore hole method

Six diameter classes were formed i.e. 30-35 cm, 35-40 cm, 40-45 cm, 45-50 cm, 50-55cm, and >55 cm depending upon the availability of trees.

Maximum oleoresin yield in bore hole method was recorded with stimulant treatment of HCl 10% + 20% ethephon (1983.89 g) and lowest yield of 886.81g/season was observed in T_3 (H_2SO_4 20% + 20% ethephon).

The interaction study between stimulant concentration and diameter classes revealed that maximum oleoresin yield of 643.25 g/hole/tree was obtained from H_2SO_4 (10% + 10% ethephon) treatment with >55 cm diameter class.

The interaction study between stimulant concentration and bore holes revealed that maximum oleoresin yield of 623.52 g/hole/tree was obtained from third bore hole with (HCl 10% + 10% ethephon) of stimulant concentration. The minimum oleoresin yield of 132.08 g/hole was recorded in first bore hole with (H_2SO_4 20% + 20% ethephon) of stimulant concentration.

The interaction study between DBH (diameter at breast height) and bore holes revealed that the maximum oleoresin yield of 787.05 g/hole/tree was obtained from third borehole with > 55cm diameter class. The minimum oleoresin yield of 95.63 g/hole was recorded in third borehole with 30-35 cm diameter class.

Rill method

Trees having diameter more than 30 cm were selected randomly for tapping. The rills were made at weekly interval and the chemical stimulants were sprayed with the help of spray bottle. The different stimulant treatments in rill method (Fig. 93) showed non-significant effect on oleoresin yield.

The highest oleoresin yield of 9.98 kg/season was recorded in T_4 (HCl 10% + ethephon 20%) and lowest yield of 5.36 kg/season was observed in T_1 (HCl 10% + ethephon 10%)

Fig. 93: Resin tapping experiment at Nauni Campus – Rill method

The resin tapping experiment at Forest Division Hamirpur (HP) was started in April, 2011 to find out the resin yielding potential of chir pine trees. The effect of different gum inducer treatments and DBH on oleoresin yield in borehole method was studied in the year 2015-16. Eight diameter classes were formed i.e. 30-35 cm, 35-40 cm, 40-45 cm, 45 – 50cm, 50 - 55cm, 55-60 cm, 60 – 65cm and > 65 cm depending upon the availability of trees. Three bore holes at different times (April-Nov, June-Nov, and Sept-Nov) were drilled in each tree. The oleoresin was collected at the end of season.

- The highest oleoresin yield of 876.00 g/season was recorded in T_1 (HCl 10% + 10% ethephon) and lowest yield of 471.20 g/season was observed in T_3 (H_2SO_4 20% + 20% ethephon).
- The highest and lowest mean oleoresin yield of 327.03 and 206.9 g/hole/tree was obtained from second and third number bore hole respectively.
- The interaction study between DBH and bore holes revealed that maximum oleoresin yield of 483.33 g/hole/tree was obtained from second borehole with 55-60 cm diameter class and minimum oleoresin yield of 76.67 g/hole was recorded in third borehole with 30-35 cm diameter class.

Relationship between the environmental factors and oleoresin yield

To study the relationship between the environmental factors and oleoresin yield the environmental data from year 2010 to 2014 were taken from the Department of Environmental Science, Dr. YS Parmar UHF, Nauni, Solan (HP). The simple environmental correlation between the oleoresin yield and environmental factors *viz*., maximum temperature, minimum temperature, average relative humidity, total sunshine hours/month, total rainfall, total evaporation and oleoresin yield was determined.

- The oleoresin yield exhibited positive significant correlation coefficient with maximum temperature (0.849998) and total evaporation (0.80904).
- The oleoresin yield had significant and negative correlation with minimum temperature (-0.548107) and average relative humidity (-0.47512).

Effect of different sites and needle colour on oleoresin yield

To study the effect of sites and needle colour on oleoresin yield, nine sites were selected i.e. Solan, Chail, Dagshai, Dharamshala, Kunalpathari, Kohala, Banjar, Riwalsar and Iarji. One bore hole was drilled for a period of one month and stimulant, H_2SO_4 20% + Ethephon 10%, was used. In this experiment the total 162 trees were tapped. The colour of needles was compared with the colour chart of the Royal Horticulture Society. The data revealed that the oleoresin yield was significantly affected by the site and needle colour.

- The maximum mean oleoresin yield of 628.22 g/hole was recorded in Kohala which was statistically at par with 580.45 g/hole was recorded in Dharamshala. The minimum mean oleoresin yield of 208.43 g/hole was observed in Dagshai
- The highest and lowest mean oleoresin yield of 564.41 and 288.53 g/hole/tree was obtained from dark green needle and light green needle colour tree respectively

The interaction study between site and needle colour revealed that maximum oleoresin yield of 904.60 g/hole/tree was obtained from dark green needle colour tree of Kohala site and minimum oleoresin yield of 120.00 g/hole was recorded in light green needle colour in Chail

1.6 Project on *Karaya* Gum at IGKVV, Raipur

Standardization of gum tapping *Karaya* (*Sterculia urens*)

The gum tapping in *karaya* trees were done at four sites *i.e.*, Navagarh, Zarjara, Chikli blocks of Gariaband districts and Churcha colliery in Korea district. Five concentrations of ethephon were used (*i.e.*, 0.78, 3.12, 2.34, 1.95 and 3.9 %) for gum tapping purpose by drill method in the year 2015-16. Following conclusions were drawn:

- Tree girth, temperature and relative humidity plays significant role in the process of gummosis in *karaya*.
- Application of 4 ml of 3.9% ethephon in two consecutive doses at one-month interval was superior as compared to lower doses. This level was found to be very effective even in lower tree girth for high production of gum.

- High elevation of tree had significantly negative impact on gum production. As compared to Church colliery (Korea) elevation of 626 m, the production was higher in Chikli village Gariyaband, elevation of 342m.

Babool (*Acacia nilotica*)

The experiment was conducted for inducing gummosis in babool trees at Naya Raipur using gum inducer (ethephon) and mechanical method of single cut in April. Two consecutive doses of ethephon were applied by drilling hole at one-month interval on April 10 and May 10, 2015 with various concentrations of stimulant viz. 0.39, 0.78, 1.36, 2.34, 3.12 and 3.91% (4ml). Four ml of ethephon (E-super @3.9%) in two consecutive applications at one-month interval was found superior over lower doses of stimulant, for gum production in babool (Fig. 94). As compared to mechanical method of gum tapping, drill method was found to be more effective in babool. Maximum gum production was achieved in the month of June. Temperature and RH played significant role in gum production.

Sustainable utilization of gum and resin by establishing improved tapping technique in *Dhawara / Ghatti* (*Anogeissus latifolia*)

Scientific method to obtain maximum gum from *dhawara* tree is not available scientifically, hence study on various tapping techniques were carried out in order to establish improved tapping method for safe harvesting of gum. The experimental site was Khargadi village (District Tidla) of Chhattisgarh. Mechanical method (one blaze, three blazes, use of die and semi arc method) and gum inducer method (use of ethephon - 0.78, 1.56, 2.34, 3.12 and 3.9%, AIA – 400 and 800 ppm, KNO3 -1% and 2% by hand girmit) was applied on March 15 and May 15, 2015. After seven days of application, gum collection was started and continued up till gum exudation was nil for each treatment. Following conclusions were drawn:

Two consecutive dose of ethephon 4ml @3.9%, applied at 30 days' interval, was found most effective in gum production (Fig. 95) over other gum inducer techniques as well as mechanical methods

In mechanical method, three blazes with axe was superior over semi arc and die method

Fig. 94: Drilling & gum exudation from *babool* tree

Fig. 95: *Dhawara* gum exudation using ethephon (drill method)

1.7 Project on *Guggul* at JNKVV, Jabalpur

Effect of foliar application of plant growth regulators and nutrients on anatomy of *Commiphora wightii* in the Chambal ravines

Three inches of tertiary branches of the treated *guggul* plants were collected on February, May, July, September, November, December 2015 and March 2016 and preserved in Formalin. Microscopic examination and quantification of sections were undertaken using an image analyzer (Leica-DM 750). The analysis of transverse section was carried out for identification of *guggul* gum ducts/mm^2 and measurement of its frequency, width and area.

The density of gum ducts/mm^2 was highest (46.68) in plant growth regulator in March. Whereas, the density of gum ducts was highest during March in all the cases except that of micro nutrients where it was maximum (37.29) in December (Fig. 96).

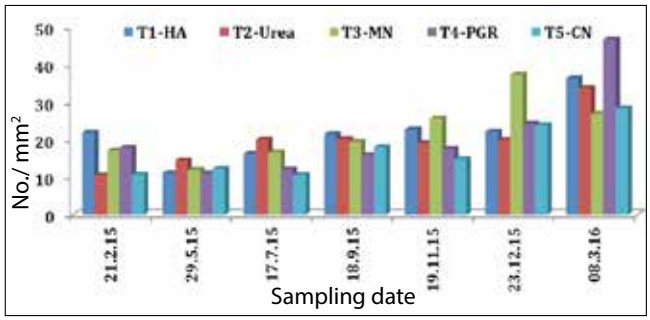


Fig. 96: Periodic variation in the density of gum ducts in *Commiphora wightii* under different treatments

Effect of different dates of sowing and seed colour on the germination and growth parameters of *C. wightii*

The experiment was conducted in JNKVV, Jabalpur during the year 2016 with six dates (D1- 8th

June, 2016, D2-12th June, 2016, D3-20th June, 2016, D4- 2nd July, 2016, D5 – 13th July, 2016 and D6 – 18th July, 2016) of sowing with Complete Randomized Design, in four replications, to Investigate the effect of the different dates of sowing and seed colour on the germination of *C. wightii* seeds.

It was found that the black coloured seeds had a higher germination as compared to light colored seeds. The higher water uptake rate and germination in black colored seeds are likely due to the degeneration of seed coat.

It was also noticed that in both light and dark coloured seeds, germination was maximum in July month.

Influence of submergence and seed colour on germination of *C. wightii* seeds

This experiment was undertaken to evaluate the germination improvement under laboratory conditions in the different periods of submergence. Seeds were soaked for T_1-00, T_2-24,T_3-48, T_4-72 and T_5-96 hours respectively in beakers with control (T_1 no submergence) then placing in plastic petri dishes in seed germinator. Seeds were kept for germination at constant temperature and humidity in the dark germinator. Fifteen days after completing treatment, germination percentage were calculated.

Dark coloured seed of *guggul* seed germination percent had the highest value (17.50%) in T_2-24 h while for the light coloured seed germination, the maximum percent (5%) was in T_2-24 h submergence

1.8 Project on Tamarind seed gum at TNAU, Coimbatore

The study aims to identify best sources of tamarind collection for maximizing tamarind kernel powder and tamarind seed gum production. During the year 2015-16, research work on pod characterization, seed characterization, tamarind kernel powder yield and tamarind seed gum production were taken up for sample collected from different agro-climatic zone of Tamil Nadu (North-western zone, Cauvery-delta zone, Southern zone, Western zone and North-eastern zone) and different age-classes (10-20 years, 20-30 years, 30-40 years, 40-50 years and 50-60 years) of tamarind tree.

Characterization of Tamarind pod

Agro-climatic variation

- Pods were graded in to six categories *viz*. one seeded, two seeded, three seeded, four seeded, five seeded and multi seeded. Also, pod length, pod width and pod shell thickness were studied for five agro- climatic zones.
- North Western zone recorded maximum number of one seeded and multi seeded pods, North Eastern zone recorded maximum number of two seeded, three seeded and five seeded pods whereas Cauvery delta zone recorded maximum number of four seeded pods.
- Maximum (13.23 cm) and minimum (2.34 cm) pod length was observed in multi seeded pod of North Western zone and one seeded pod of Cauvery delta zone, respectively.

- North Western zone accounted maximum (2.73cm) and minimum (1.43cm) pod width in two seeded and one seeded pod respectively.
- Among the different agro-climatic zones, pod shell thickness ranked in the order of 0.103 cm (Western zone) > 0.089 cm (North Eastern zone) > 0.081 cm (Cauvery delta zone) > 0.060 cm (Southern zone) > 0.054 cm (North Western zone).
- The pod shell content (%) varied from 28.75 per cent (North Western zone and North Eastern zone) to 34.96 per cent (Cauvery delta zone). Similarly, the seed content of the pod was minimum (24.66 %) in Cauvery delta zone and maximum (29.41 %) was observed in North Western zone of Tamil Nadu.
- High variation in fibre content was observed with the values 2.53 per cent (Cauvery delta zone) to 5.51 per cent (North Western zone). Pulp content was accounted to be lowest (35.93 %) in Southern zone and highest (40.92 %) was in North Eastern zone.

Age-classes variation

- In one, two and three seeded pods, maximum number of pods per kg were found in age class of 20-30, 50-60 and 10-20 years, respectively. In age class of 40-50 years, four, five and multi seeded pods were in maximum count.
- Pod biometrics (pod length, width and shell thickness) was recorded maximum in age class of 30-40 years for one, two, three and multi seeded pods. For four and five seeded pods it was maximum in age class of 50-60 and 10-20 years respectively.
- Tamarind seed and pulp content was maximum in age class of 40-50 and 50-60 years respectively. Whereas pod shell and fibre content was maximum in age class of 10-20 years.

Characterization of Tamarind seed

Agro-climatic variation

- Weight of tamarind seeds varied from 101.06 to 66.32 g/100 seeds for North Western zone and Cauvery delta zone respectively.
- Length and width of tamarind seed was maximum (1.46cm and 1.01cm respectively) for North Western zone and minimum (1.27cm and 0.88 cm) for Western zone and North Eastern zone respectively.
- Cauvery delta zone accounted for maximum number of small and big size seeds/kg of tamarind seeds and Southern zone accounted for maximum number of medium size seeds/kg of tamarind seeds. Sieve sizes namely, <9.5 mm (Small seeds), 9.5 mm (Medium seeds) and 11.2 mm (Big seeds) were used for grading (size wise).
- Tannin content in tamarind seed coat was maximum (301.84 mg g-1) and minimum (240.35 mg g-1) in Western and Southern zone respectively.

Age-classes variation

- The age class of 40-50 years was observed maximum 100 seed weight of 94.26 g, which was statistically on par with the age class of 30-40 years (92.96 g). The minimum was observed in age class of 10-20 years with the 100 seed weight of 71.41 g.
- The maximum seed length of 1.56 cm and minimum seed length of 1.19 cm was recorded in age class of 50-60 and 10-20 years respectively. Whereas, lowest seed width (0.65 cm) was observed in age class of 20-30 years and highest in age class of 50-60 years with the value of 0.99 cm.
- Maximum number of big, medium and small size seeds were recorded in 10-20, 20-30 and 40-50 years respectively.
- Highest tannin content (285.13 mg g-1) was found in seed coat of age class of 10-20 years. Whereas minimum tannin content (259.66 mg g-1) was found in seed coat of age class of 20-30 years.

Characterization of Tamarind kernel powder

Agro-climatic variation

- The sources from North Western zone recorded highest tamarind kernel powder outturn (80.42 %) followed by Southern zone (77.53 %), Western zone (70.17 %), North Eastern zone (67.90 %) and the lowest was observed in Cauvery delta zone with the outturn of 62.68 per cent.

Age-classes variation

- The maximum tamarind kernel powder outturn was recorded in age class of 40-50 years with the value of 80.96 per cent, followed by age class of 30-40 years (80.34 %), age class of 10-20 years (79.61 %), age class of 20-30 years (77.47 %) and the minimum outturn of tamarind kernel powder (75.78 %) was obtained in age class of 50-60 years.

Tamarind seed gum yield

Agro-climatic variation

- The quantity of tamarind seed gum (TSG) extracted from one kilogram of tamarind kernel powder (TKP) reflects the seed gum yield. TSG was prepared by boiling the slurry (20g TKP/ 1 litre distill water) for 20 min, followed by centrifugation (20 min, 5000 rpm) of slurry and drying (110^{0}C for 12 h) of supernatant solution. The seed gum was observed maximum in North Western zone with the yield of 139.54 g gum/kg of tamarind kernel powder, followed by Southern zone (131.11 g/kg), Western zone (128.89 g/kg), North Eastern zone (123.46 g/kg) and the minimum (116.71 g/kg) was observed in Cauvery delta zone

Age-classes variation

- The tamarind seed gum yield from 1 kg. of tamarind kernel powder was studied in different age-classes and was ranked in the order of 148.65 g/kg (40-50 years) > 145.18 g/kg (30-40 years) > 141.37 g/kg (20-30 years) > 135.03 g/kg (50-60 years) > 134.60 g/kg. (10-20 years).

Development of dehuller for tamarind

Tamarind dehuller unit (Fig. 97), consisting of feed hopper, set of crushing rolls, beater assembly, sieve, aspirator and outlets, was developed by TNAU, Coimbatore. Over all dimensions of this machine are 900 mm x 800 mm x 1200 mm. The feed hopper is made of 20-gauge mild steel with a capacity of 15 kg per hour. The entire unit was mounted on Mild Steel angle 1200 x 900 mm stand. Dehulling efficiency of tamarind dehuller was estimated to be 83.70 per cent.

Fig. 97: Tamarind Dehuller Unit

1.9 Project on Natural Dammars at KAU, Thrissur

Standardization of dammar tapping process for *Canarium strictum* trees

Three different tapping methods were studied for black dammar extraction from *Canarium strictum* trees. Ist, IInd and IIIrd grade dammers were obtained from trees. Trees belonging to various diameter classes (<50cm, 50-100cm, 100-150cm and >150cm) were selected for tapping. In all cases maximum amount of dammar was collected from trees having girth class > 150cm. Black dammar exudates from bark of *C. strictum* tree.

Box type method

In this method, bark of tree was removed in the form of a box (20 cm ×20 cm) and dammar was collected (at Malakkapara) after one month of bark removal (Fig. 98). The advantage of this method was the easy procedure and its simplicity. But removal of bark and exposure of a large area adversely affects the tree growth.

Fig. 98: Box type method of resin collection in *Canarium strictum*

Bore hole method

This method was studied in two different sites in Kerala (Malakkapara and Nelliamapthy). The highlight of this method was the minimum removal of bark and the maximum collection of resin. In this method, a strip of bark was removed and a slanting pipe of 5 cm long was inserted at the bottom of the strip. A plastic bag was attached to the slanting pipe for collection of the resin. Then the cut portion was covered with a plastic sheet. Majority of resin obtained in the method were in first quality in nature. But only a small quantity of resin was collected in this method and large amount of resin flowed to other area adjacent to the mouth of slanting pipe. But complete target was not achieved in this method because of the hardness of resin and clogging of the top of the vial when it was exposed to air.

Strip cut method

This method was a modification of bore hole method. In this method, a small portion of bark was removed from the *C. strictum* tree and half blown polythene cover was fixed underneath this cut. The resin oozes through the strip and flows to the polythene cover directly (Fig. 99). The advantage of this method was the minimum injury to the wood and the resin oozes directly to the cover. The total quantity of resin collected (after one month) was relatively higher when compared to the other methods and also the maximum amount (90%) of first grade dammar was collected in this method. Hence, strip cut method was found to be more efficient method in dammar extraction.

Fig. 99: Strip cut method of resin collection in *Canarium strictum*

Standardization of dammar tapping process for *Vateria indica* trees

Two different methods were analyzed for white dammar collection from *Vateria indica* trees and three grades (Ist, IInd and IIIrd) of dammar were obtained. Four various diameter classes (<50 cm, 50-100 cm, 100-150 cm and >150 cm) were selected for tapping. White dammar exudates from the sap wood of the tree.

Box type method

Box type (20 cm ×20 cm) cuttings were tried in *V. indica* trees at Malakkapara as well as at Peechi. This method was not successful because only small quantities of resin were obtained from this method. The amount of resin collected by this method was very low. However, the trees with girth > 150 cm produced more quantity of resin.

Deep cut method

In this method deep cuts were made at a depth of 2-3 cm on the wood (Fig. 100). This method yielded relatively high amount dammar when compared to other method. It was observed that the resin yield increased with increasing girth of trees. However, at Peechi, the yield was more in the girth class ranges from 100-150 cm. This method had significant

influence in the production of first quality and third quality resins from the trees at Malakkapara and Peechi respectively.

Fig. 100: Deep cut method of resin collection in *Vateria indica*

It was noticed that *V. indica* trees exudates more resins from natural injuries than manmade injuries. Whereas *C. strictum* trees exudate more amount of resin from natural as well as artificial wounds.

1.10 Project on Pinus *kesiya* Resin at ICAR-Research Complex for NEH Region, Umiam

Standardization of resin tapping process for *Pinus kesiya* trees

For Oleoresin tapping study, *Pinus kesiya* grown in agroforestry experimental field of ICAR Research Complex for NEH Region Umiam, Meghalaya were tagged. A total of 482 matured *P. kesiya* trees were tagged individually for bore hole tapping. CBH (circumference at breast height) of all the *P. kesiya* trees were measured and then grouped into three different diameter classes *viz*., 30-40 cm, 40-50 cm and >50 cm for experimental purpose.

Resin was extracted month wise from the trees of different diameter classes viz 30-40 cm, 40-50 cm and >50 cm diameter class. Maximum resin yield was noticed in the month of September, 2015 in tree of >50 cm diameter class (342.11 g tree^{-1})

On monthly basis, average resin yield was maximum (194 g tree^{-1}) and minimum (145 g tree^{-1}) for >50 cm diameter class and 30-40 cm diameter class trees respectively.

Characterization of oleoresin for its physico-chemical properties

Resin was processed by steam distillation and rosin and turpentine percentage was estimated in the resin extracted from these three diameter classes. Mean turpentine yield was found to be 14.97 per cent, 15.07 per cent and 16.36 per cent respectively in 30-40 cm, 40-50 cm and > 50 cm diameter class. Although there is variation in turpentine percent among different diameter classes, the difference is non-significant in the small data set. Total oleoresin collection, for the duration of five months (November to March), was found to be highest in 40-50 cm diameter class (Fig. 101).

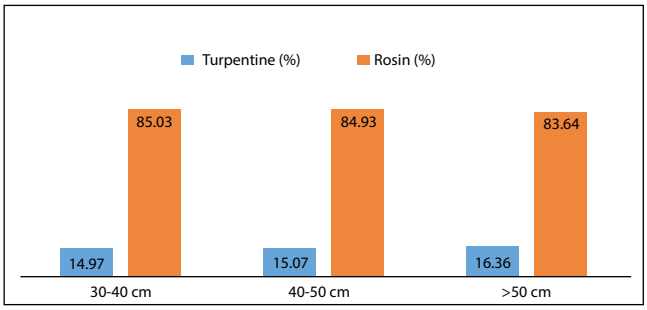


Fig. 101: Variation in rosin and turpentine yield in different diameter classes of *Pinus kesiya*

2. Network project on Conservation of Lac Insect Genetic Resources

2.1 Lead Centre: ICAR-Indian Institute of Natural Resins and Gums, Ranchi

Propagation of *F. semialata* on *F. macrophylla*

Vegetative propagation methods like budding, cleft grafting and inarching were continued on *macrophylla* with *semialata*. Twenty five each were inarched, cleft grafted and budded between *semialata* and *macrophylla*. Five and ten were successful on inarching and cleft grafting respectively whereas budding did not perform well (Fig. 102).

Inarched plants

Cleft grafted plants

Fig. 102: Vegetative propagation of *F. semialata* on *F. macrophylla*

Forecasting of lac insect larval emergence

This study was continued during different crop seasons 2015-16. To correlate different stages of yellow spot appearance with embryonic development and actual larval emergence for improved and accurate forecasting. Lac insect female cells were collected and grouped into six different stages (Stage 0, 1,2, 3, 4 and 5) based on appearance of yellow spot. Photographs were taken of female cell with yellow spot appearance and developing embryo in the mother cells were observed under microscope. Time lag relation (in days) between initiation of larval emergence and different stages of yellow spots varied greatly. Number of days for actual larval emergence was also varied in different seasons (Table 23).

Table 23. Forecasting of lac insect larval emergence in different stages

Stages	Number of days to emerge			
	Baisakhi 2015-16	*Katki* 2016	*Aghani* 2015-16	*Jethwi* 2016
Stage 0	9.05±3.01	8.38±2.06	22.00±6.99	12.50±2.96
Stage 1	6.42±1.98	5.94±1.20	15.63±4.78	10.30±3.03
Stage 2	5.05±2.33	5.08±1.60	12.85±4.39	7.14±3.10
Stage 3	4.18±1.71	4.36±1.43	5.06±1.95	6.52±1.64
Stage 4	2.47±1.07	2.26±0.72	3.26±1.12	3.84±1.84
Stage 5	1.65±0.48	1.32±0.47	1.09±0.36	1.74±0.88

Broodlac quality of lac insects

Broodlac quality study was done with different quality of broodlac *viz*., 25, 50, 75 and 100 per cent lac encrustation harvested from different lac hosts for *baisakhi* 2015-16 (*palas*), *katki* 2016 (*ber*), *aghani* 2015-16 (*ber*) and *jethwi*, 2016 (*kusum*). Maximum lac crawlers emerged on 10, 9, 9 and 11days after harvesting of broodlac and most of the crawlers were emerged upto 10, 15, 15 and 20 days after harvesting of broodlac during *baisakhi* 2015-16, *katki* 2016, *aghani* 2015-16 and *jethwi*, 2016, respectively (Fig. 103-106).

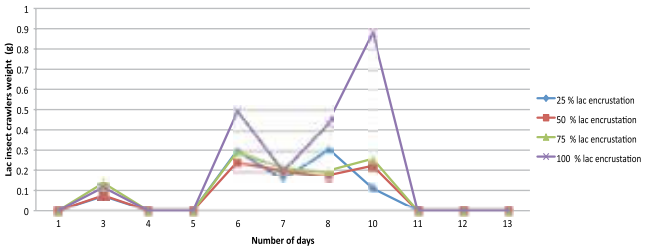


Fig. 103: Crawler emergence in different quality of broodlac during *baisakhi* 2015-16

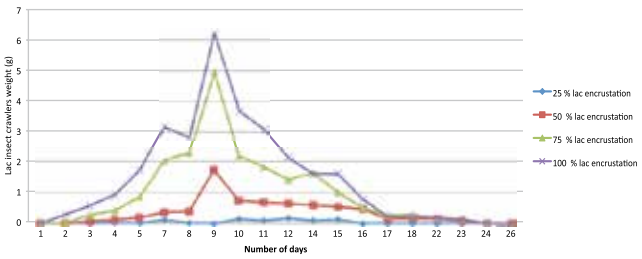


Fig. 104: Crawler emergence in different quality of broodlac during *katki* 2016

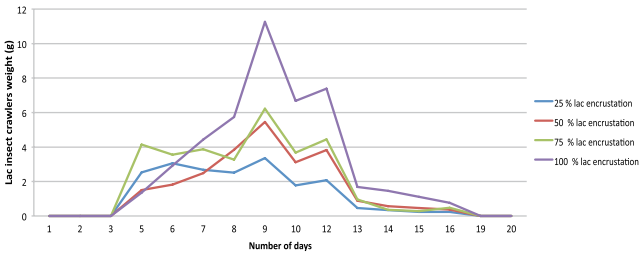


Fig. 105: Crawler emergence in different quality of broodlac during *aghani* 2015-16

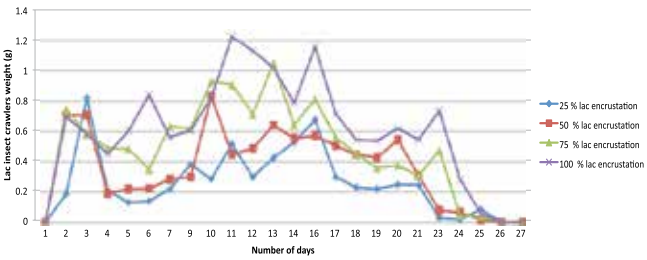


Fig. 106: Crawler emergence in different quality of broodlac during *jethwi* 2016

To address the freshness assessment of the broodlac, the rate of weight reduction of broodlac was taken as an indicative parameter. Rate of reduction in weight of broodlac in different categories *viz*., 25, 50, 75 and 100 per cent lac encrustation was calculated in *palas* (1.78, 1.60, 1.31 and 1.87 per cent per day) during *baisakhi* 2015-16, *ber* (0.4, 0.6, 0.6 and 0.9 per cent per day) during *katki* 2016, *ber* (0.97, 1.08, 1.79 and 1.70 per cent per day) during *aghani* 2015-16 and

kusum (2.7, 3.3, 4.0 and 4.1 per cent per day) during *jethwi* 2016 (Fig. 107-110). The study also revealed that the rate of reduction in broodlac weight became near constant after 14, 15, 14, 11 days during *baisakhi* 2015-16, *katki* 2016, *aghani* 2015-16 and *jethwi* 2016, respectively. The curve fitting model based on the rate of weight reduction can be used for prediction of freshness of broodlac samples.

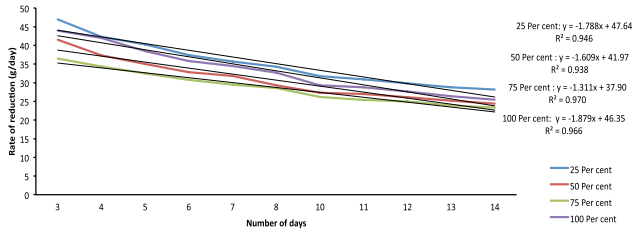


Fig. 107: Rate of weight reduction with different quality of broodlac during *baisakhi* 2015-16

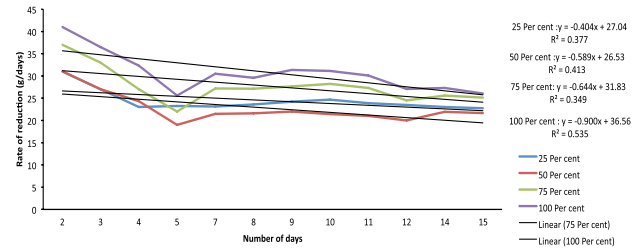


Fig. 108: Rate of weight reduction with different quality of broodlac during *katki* 2016

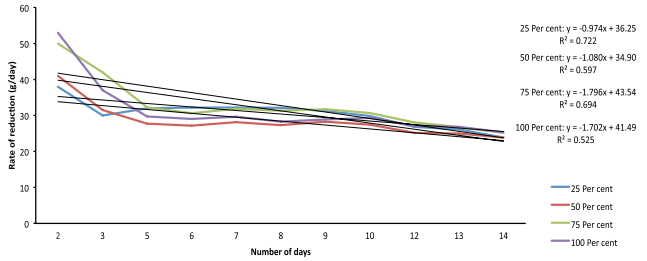


Fig. 109: Rate of weight reduction with different quality of broodlac during *aghani* 2015-16

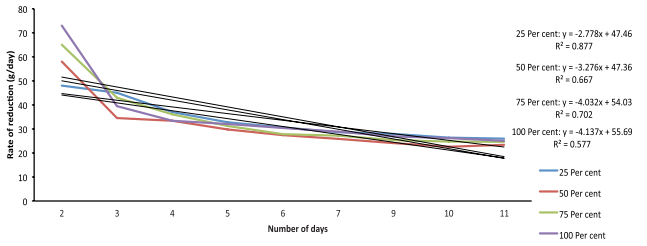


Fig. 110: Rate of weight reduction with different quality of broodlac during *jethwi* 2016

NP-CLIGR cooperating center The Professor Jayashankar Telangana State Agricultural University, Hyderabad and Kerala Forest Research Institute (KFRI), Thrissur were monitored during 10-14th May, 2016. Lac insect was observed on *Ficus benghalensis, F. religiosa* and *F. recemosa* at Masigunda near temple, Mahboonagar district, Telangana. Lac is being used for fixing arrows and wound healing by Chenchu tribals at Sarlapally, Telangana (Fig. 111 & 112). Home garden with *F. semialata* one of the components for lac cultivation was developed by KFRI, Thrissur (Fig. 113).

Fig. 111: Lac insect on *Ficus benghalensis* at Masigunda

Fig. 112: Lac used as fixing arrows by Chenchu tribals at Sarlapally

Fig. 113: *F. semialata* as a component of home garden for lac cultivation at Thrissur

Barcoding of new lac insect collections

Twenty one new lac insect lines collected from different regions of the country (Kerala, Manipur, Meghalaya and Punjab) have been characterized using cox1 barcode gene. The results are given in Table 24. The lac insects collected from Manipur and Meghalaya matched with *Kerria chinensis* whereas the lac insect lines collected Kerala and Punjab matched with *Kerria lacca*.

Table 24. Barcoding of new lac insect lines

State	Code	Product length (bp)	Per cent Homology	Matching with
Kerala	K1	665	91%	LIK008
Kerala	K3	647	92%	LIK008
Manipur	MF2	662	81%	LIK0031
Meghalaya	MeF1	549	77%	LIK0031
Meghalaya	MeG1	542	84%	LIK0031
Punjab	PBPZ6	563	77%	LIK0032
Punjab	HRPZ6	541	78%	LIK0011
Punjab	DLPZ2	487	88%	LIK0011
Punjab	PBPZ7	471	88%	LIK0039
Punjab	PBPZ8	470	89%	LIK0039
Punjab	PBPZ11	474	90%	LIK0039
Punjab	PBPZ15	442	91%	LIK0011
Punjab	UPPZ15	487	88%	LIK0043
Punjab	UPPZ16	462	90%	LIK0019
Punjab	DLPZ5	480	92%	LIK0043
Punjab	HRPZ2	485	82%	LIK0043
Punjab	HRPZ3	467	86%	LIK0039
Punjab	PBPA3	495	87%	LIK0011
Punjab	PBPZ5	490	99%	LIK0058
Punjab	PBPZ9	497	99%	LIK0058
Punjab	PBPZ14	496	99%	LIK0058

EST-SSR study of lac insect collections

Expressed Sequence Tag – Simple Sequencing Repeat (EST-SSRs) markers have been developed from the transcriptome data of lac insects. Thirty-one EST-SSR markers were used to analyze 27 lac insect lines collected from different regions of the country and one exotic line. The dendrogram obtained through the analysis have clustered all the lac insect lines into 3 distinct clusters; first comprising of *K. chinensis* lines, second comprising mainly of *rangeeni* and third comprising of *kusmi* lines (Fig. 114).

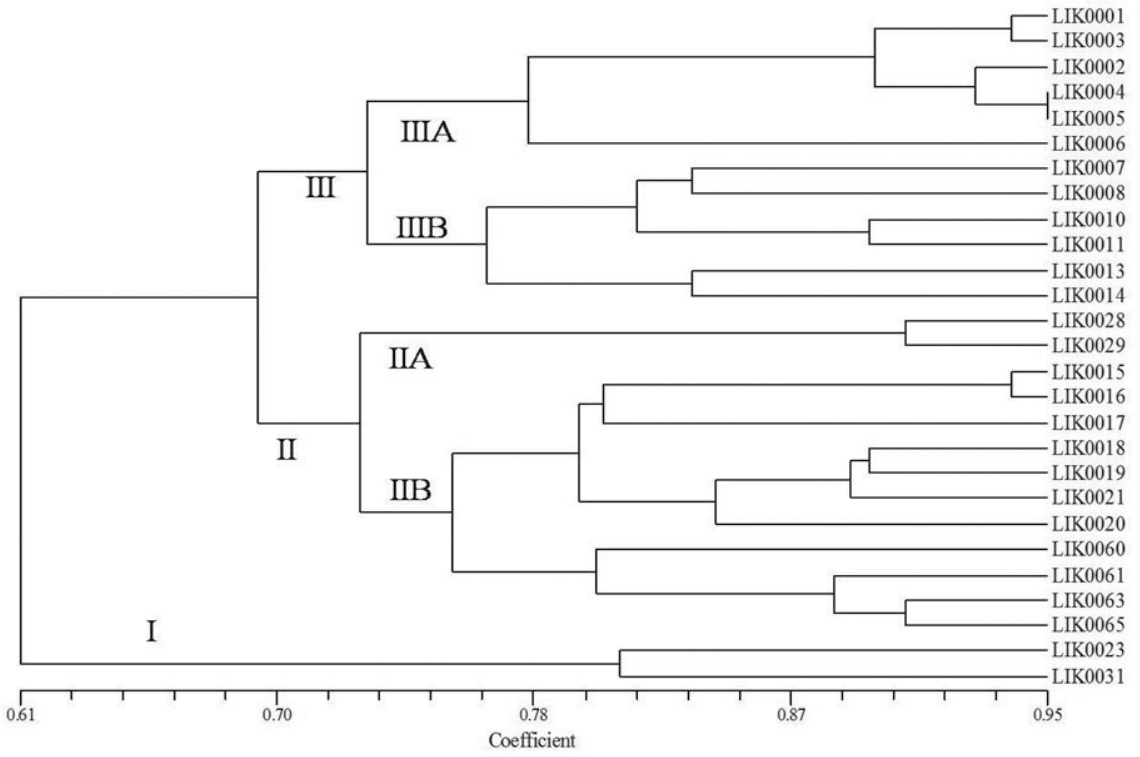


Fig. 114: UPGMA dendrogram of 27 germplasm of *Kerria* spp based on 31 EST-SSR primers

Insect-host plant interaction

To understand the lac insect-host plant interaction a study was initiated on the influence of lac insect feeding on biosynthate changes in *Kusum* (*Schleichera oleosa*) tree. *Kusum* tree was inoculated with *kusmi* strain of Indian lac insect (*Kerria lacca* Kerr) in the month of February 2016. The biochemical parameters *viz*., total sugar, total soluble protein, free phenol, total chlorophyll, carotenoid and one stress indicator proline were studied from the leaves of inoculated tree and compared with un-inoculated tree i.e. control.

The study revealed that upon inoculation 34% increase in total sugar was observed in lac inoculated tree over control.

Total soluble protein was increased by 46.28 % in lac inoculated condition over control.

Total free phenol was increased by 94.49% and carotenoid by 83.93 % in lac inoculated condition over control. As far as total chlorophyll is concerned there is no change observed.

Continuous feeding on host plants and profuse honey dew secretion by lac insect leads to moisture stress inside the plants as evident from high accumulation of proline in the leaves of the lac inoculated tree (568.75%) compared to control. This shows that water content in the plant is highly influenced by sap sucking insects.

Thus the present study reveals triggering of variety of biochemical and physical defense mechanisms in response to lac insect feeding on the host plants (Fig. 115 &116).

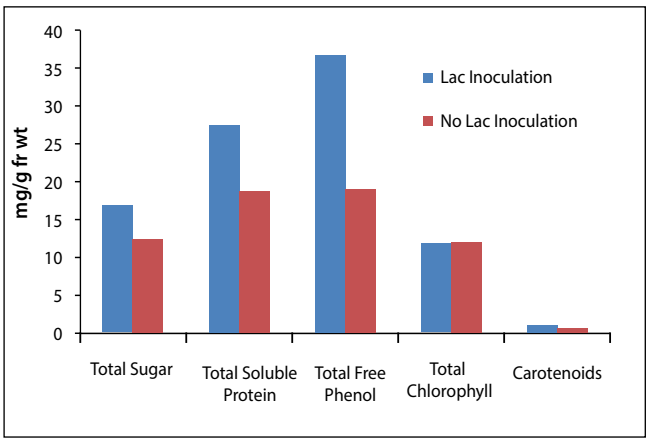


Fig. 115: Effect of lac inoculation on biochemical aspect of host plant

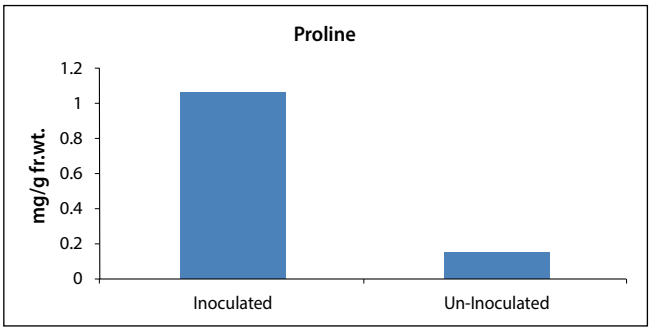


Fig. 116: Proline content in inoculated and un-inoculated host plant

Dry matter partitioning in lac ecosystem

A net house was created for studying the elemental and biomass partitioning in lac ecosystem (Fig. 117).

Fig. 117: Insect proof net house fabricated for the study

The initial data related to biomass partitioning in *F. semialata* reveals that due to inoculation of lac insect, the biomass required for the growth of lac insect is compensated from the dry matter of both stem and root when no fertilizer was applied to the system. When fertilizer mixture of NPK was applied to the system, all the components viz. stem root and leaf were compensated for the extra addition of lac insect biomass due to inoculation (Fig. 118).

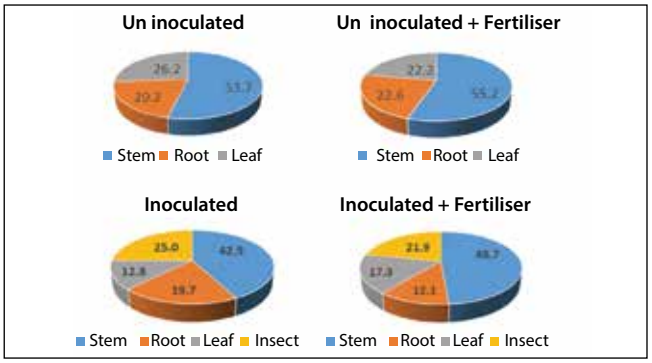


Fig. 118: Effect of lac inoculation with and without fertilizer application on biomass partitioning (dry weight basis)

The sugar content of host plant was affected negatively due to lac inoculation both with and without fertilizer application (Fig. 119.)

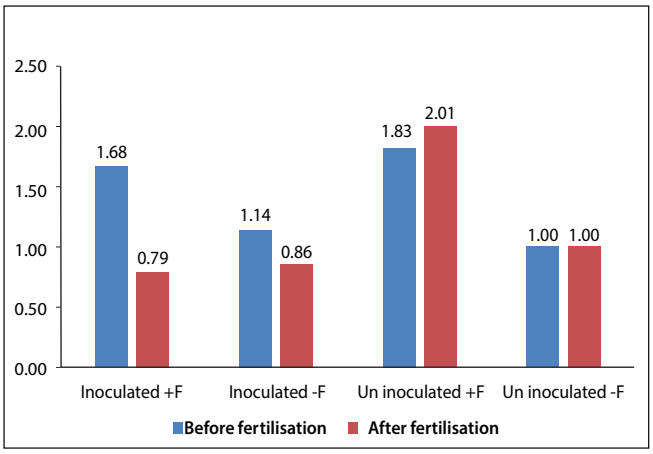


Fig. 119: Effect of lac inoculation on sugar content of the host plant *F. semialata*

Network Co-operating Centres

2.2 Central Agricultural University (CAU), Imphal

Survey of 5 districts in Manipur, 2 districts in Nagaland, 2 districts in Meghalaya and 2 districts in Tripura was carried out for collecting lac insect and host plant diversity. Colour variation was observed between the Imphal west and east collection. ITK on method of producing sealing wax and lac dye has been documented from Meghalaya. Information on traditional method of brood lac inoculation in Meghalaya was recorded (Fig. 120 & 121). A new activity on "integration of lac-culture with apiculture" has been undertaken. Two new activities viz. Lac processing unit mainly for dye and wax and screening of native varieties of *Malvaviscus sp*. (China rose) against lac insect found in Manipur has been initiated. Publication of article entitled, Lac insect in Manipur- A Case study, September 2016 in CAU, Farm Magazine, Vol 6(3):16-18 and two leaflets titled Cultivation of Lac insects and Lac insects and its importance for distribution at CAU Regional Agrl. Fair 2016, held at CAU, Imphal on 10th -12th Nov, 2016 has been carried out.

Fig. 120: Traditional method of broodlac inoculation in Meghalaya

Fig. 121: Use of lac dye for dying cloth by localities in Meghalaya

2.3 Kerala Forest Research Institute (KFRI), Thrissur

74 sites in Tamil Nadu (from 11 districts), 14 in Karnataka (from 4 districts) and 1 site from Kerala (from 1 district) were surveyed during the reporting period for the collection of lac insects and host plants. From the survey data, it was inferred that the elevation has no effect on the presence of lac as the survey revealed the presence of lac insect on various altitudes (Fig. 122). Gene bank of lac host plants is being maintained in KFRI field station at Kottappara, Ernakulam in one acre space. 220 saplings of *Flemingia semialata* and *Flemingia macrophylla* has been planted for gene bank establishment. Training on Lac cultivation technique was conducted for 14 farmers when Dr. A Mohanasundaram, Scientist, ICAR-IINRG visited KFRI on 14th May 2016. Factors affecting introduction of lac farming in Kerala was described by the PI. Insect pest complex of *F. semialata* has been recorded for documentation. Productivity linked parameters- of lac insect collected from Vellore and that from *B. monosperma* has been carried out.

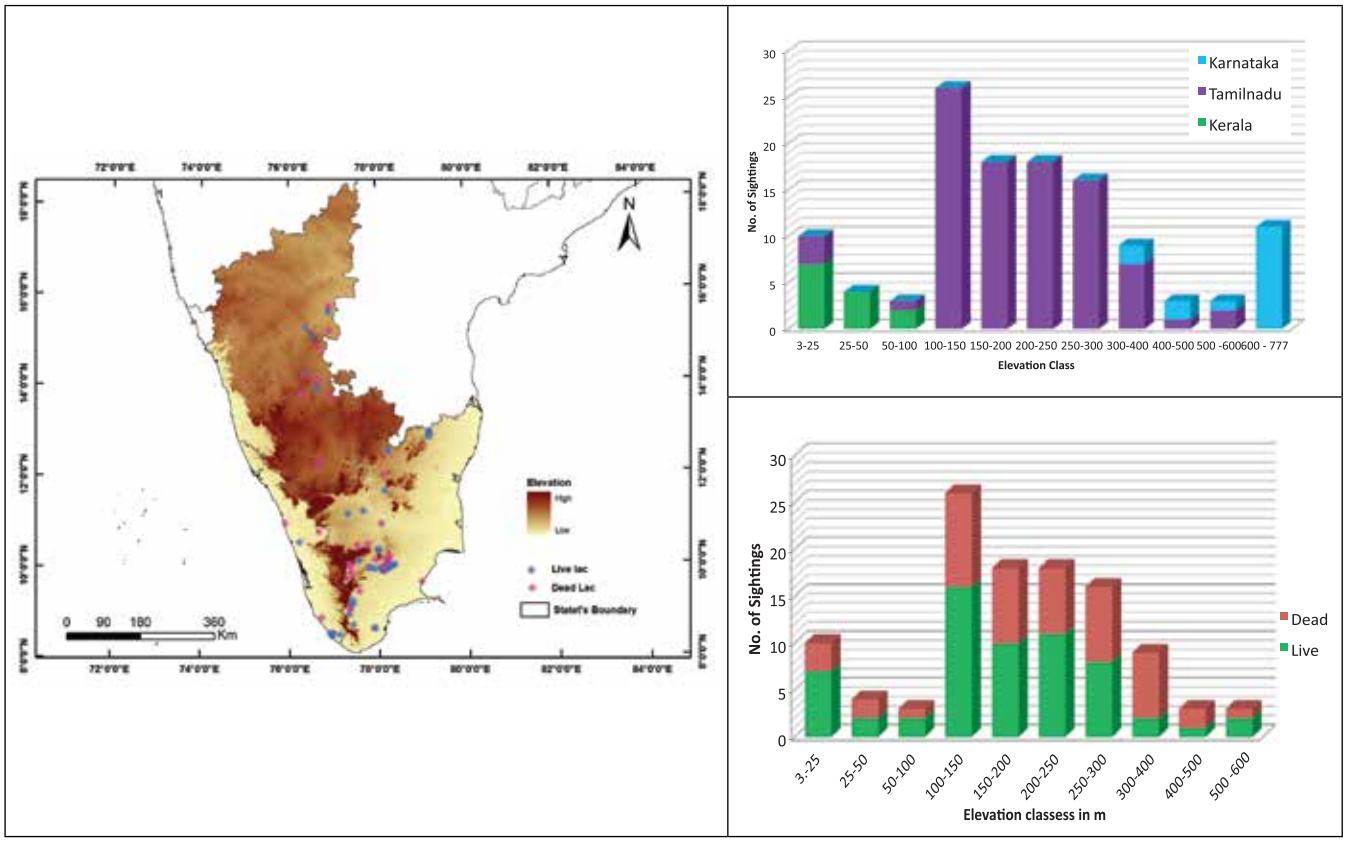


Fig. 122: Elevation range of lac and its distribution in Kerala, Tamil Nadu and Karnataka

2.4. Maharana Pratap University of Agriculture & Technology (MPUAT), Udaipur

Survey of 24 districts in Rajasthan, 28 districts in Gujarat, and 18 districts in Haryana was carried out for collecting lac insect and host plant diversity. For ex-situ conservation of collected lac insects, establishment of *F. semialata* was a challenging task due to poor germination of the seeds and slow growth characteristics of the saplings. Majority of the collections (203 Nos.) are now being maintained on *arhar* plants. Herbariums of all the host plants collected are being maintained. Five Mass awareness campaign and four Farmer's Trainings were conducted in Gujarat, Haryana and Rajasthan. Lac museum has been fully established and equipped with all relevant display materials related to lac. Knowledge sharing about Lac cultivation with farmers (approx. 2000 Nos) was carried out during Global Rajasthan Agritech Meet (GRAM) held at Jaipur during 8-11 November 2016. One M.Sc and One Ph.D student are doing work on topic related to lac at the center. One booklet, one leaflet, four folders and four posters related to lac has been prepared and distributed among farmers (Fig. 123 to 125).

Fig. 123: Herbariums maintained for Lac host plants

Fig. 124: Farmers training at Mavli, Udaipur

Fig. 125: Lac museum established at MPUAT, Udaipur

2.5 Punjab Agricultural University (PAU), Ludhiana

Survey of 6 districts in Punjab, 11 districts in Haryana, and 14 sites in Delhi and 22 districts in Uttar Pradesh was carried out for collecting lac insect and host plant diversity during the reporting period. Productivity linked parameters of lac insect on *F. semialata* has been recorded. The duration of female and male cell differentiation was observed to be 19.6 days; male emergence initiated after 42.6 days. Initial settlement density of lac insect was 45.2/ cm^2 and initial mortality was 38.72 per cent; Percentage male insects were 65.49 (Table 25). Study on associated fauna visiting *Flemingia* plants have initiated. One paper entitled, Survey on lac insect *Kerria lacca* (Kerr) in different regions of Punjab has been presented in conference.

Table 25. Productivity linked parameters of lac insect of *F. semialata*

Productivity linked parameters	Lower	Middle	Upper	Mean
Initial density settlement (No/cm^2)	32.6	55.0	48.0	45.20
Initial mortality (21 days after inoculation) (No/cm^2)	21.2	26.4	33.0	38.72
Sex ratio (Per cent male insects)	60.5	68.94	67.04	65.49

2.6 Prof. Jayshankar Telangana State Agricultural University (PJTSAU), Hyderabad

Four districts in Telengana have been covered during survey. The Lac insects were reported from areal root of *Ficus* plants. 7 farmers have been identified for promoting lac cultivation in Adilabad District.

2.7 Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Jammu

Six districts in Jammu & Kashmir and six districts in Himachal Pradesh have been covered during the reporting period for survey and collection of lac insects. A new broodlac farm is being established for quality broodlac production at the center. Certificates of recognition for successful farmers for their conservation efforts had been carried out by the center. One day farmers training programme was conducted at Raya. Involvement of B.Sc. students of SKUAST Jammu in lac cultivation has been initiated.

2.8 State Forest Research Institute (SFRI), Jabalpur

Eleven districts of Madhya Pradesh and 10 districts in Maharashtra have been covered during the reporting period for survey and collection of lac insects. Lac insect was found in *Ficus citrifolia, Annona squamosa, Acacia auriculiformis, Butea monosperma, Ficus religiosa, Schleichera oleosa, Diospyrosme lanoxylon*. Lac insect was collected during survey which was conserved, multiplied and studied biological attributes under ex-situ condition in Regional Lac Insect field gene Bank. One workshop on Lac cultivation by scientific method was conducted at Madosa Village, Panna district. One brochure and three popular articles were published about lac cultivation. Lac host biodiversity of major lac producing districts of MP has been recorded (Fig. 126).

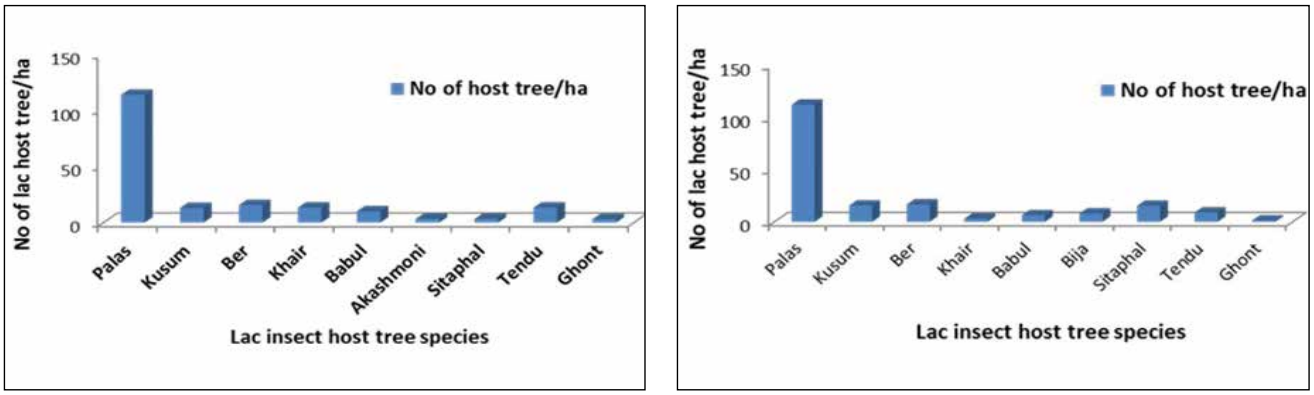


Fig. 126: Lac host plant diversity at high lac production zone of Balaghat and Seoni districts of Madhya Pradesh

2.9 Assam Agricultural University (AAU), Jorhat

Seven districts in Assam and 3 districts in West Bengal have been covered for collection of lac insect-host biodiversity. Five new potential pockets of naturally occurring lac insect in Assam and West Bengal has been identified. A new project proposal was proposed entitled, Management of *Callosobruchus chinensis* Linn- a stored grain pest of *Flemingia* spp. A new strain of *Beauveria bassiana* (strain KR855715) was isolated and identified from *Somenas cintillans* which is being tested against *Eublemma amabilis* which showed 100% mortality (Fig. 127).

Fig. 127: *B. bassiana* (KR855715) treated *Eublemma* sp.

Monitoring visits of the lead center scientists during the period

Sl. No.	Name of the scientists visited	Center(s) visited	Remarks
1.	Dr. Md Monobrullah	SKUAST, Jammu	Conducted one day training programme for farmers.
		PAU, Ludhiana	Monitored the progress.
		CAU, Imphal	Monitored the progress.
2.	Dr. A Mohanasundaram	KFRI, Thrissur	Conducted one day training programme for farmers on lac cultivation.
		PJTSAU, Hyderabad	Surveyed for lac insect collection.
3.	Dr. Anees K	SFRI Jabalpur	Monitored the progress.
		MPUAT, Udaipur	Conducted one day training programme for farmers on lac cultivation.

3. Network Project on High Value Compounds and Phytochemicals (ICAR-IINRG, Ranchi Centre)

Synthesis of hydrogel from *guar* and *moringa* gum

Moringa gum and *guar* gum based hydrogel polymers were synthesized varying the concentration of monomer, cross linker and initiator. The characterization with SEM, elemental analysis FTIR and thermal analysis has been completed. For investigating application of *guar* gum based hydrogel in heavy metal absorption study has been conducted.

Effect of adsorbate solution pH

To study the effect of pH of Cr (VI) solution on its sorption capacity by the hydrogel, sorption experiments were carried out at a pH range of 3–10. The percent removal of Cr (VI) significantly decreases upon increasing the pH value from 3, 7 and 10. The percent removal is higher in acidic than in alkaline medium. Under acidic conditions, the surface of the sorbent becomes more protonated and attracts anionic species of Cr (VI). As the pH increases, the protonation of the sorbent surface decreases leading to reduction in the electrostatic attraction between the Cr (VI) species and the sorbent surface, with a consequent decrease in the percentage removal of Cr (VI) (Fig. 128).

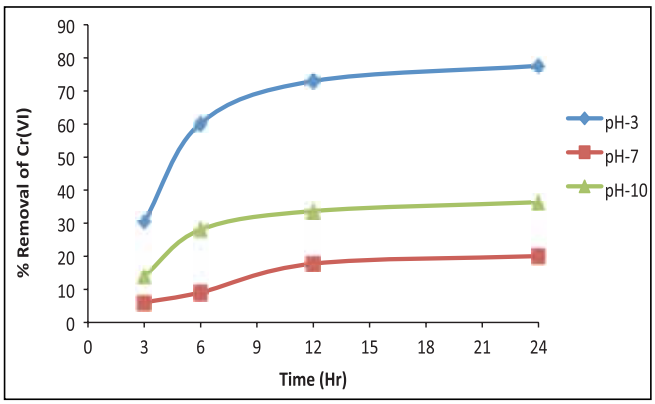


Fig. 128: Effect of solution pH on per cent removal of Cr (VI)

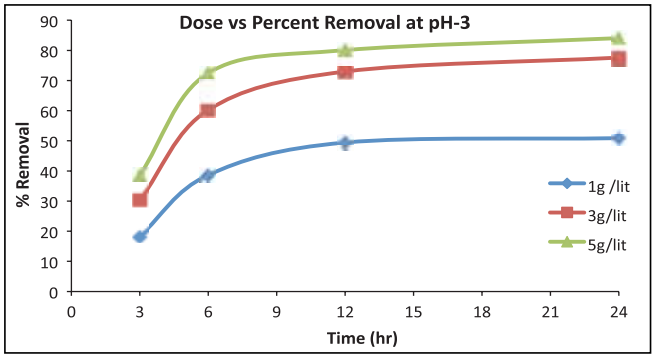


Fig. 129: Effect of adsorbent dose on per cent removal of Cr(VI) at pH-3

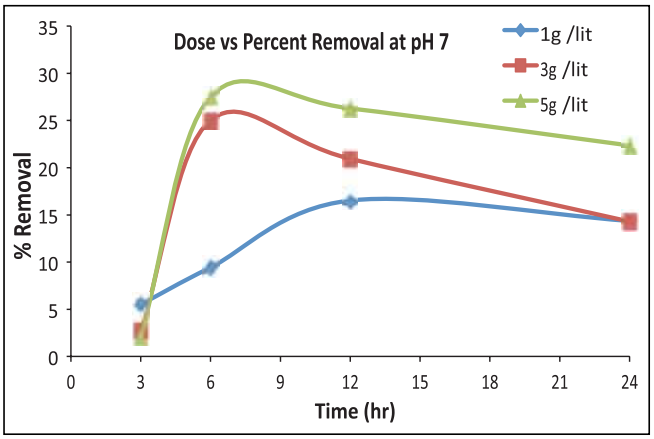


Fig. 130 : Effect of adsorbent dose on per cent removal of Cr(VI) at pH-7

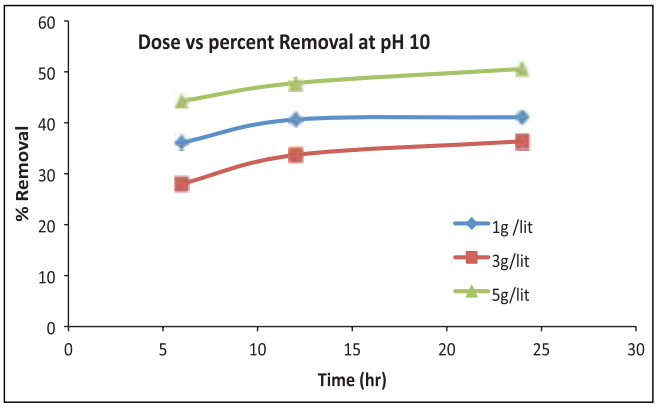


Fig. 131: Effect of adsorbent dose on per cent removal of Cr^{2+} (VI) at pH-10

Effect of sorbent concentration

To investigate the effect of sorbent concentration on the amount of sorbed Cr (VI), the sorbent concentration was changed in the range (1–5 g/l), keeping constant adsorbate concentration and keeping other sorption parameters, like pH, temperature and immersion duration constant.

The percent removal of Cr (VI) increases by increasing the sorbent concentration. That is, the percent removal increased from 54 to 93% as the hydrogel dose increased from 1 g/l to 5 g/l. This can be associated with higher available surface area, and more available sorption sites at higher sorbent doses. (Fig. 128 to 131).

Approved on-going Research Projects

S. No.	Project No.	Title of the Project	Principal Investigator
Core Program – I : Productivity and Quality Improvement			
1.	1.1.031	Collection, conservation, characterization and documentation of lac insect and host plant bio-diversity and potentiality trials.	Dr. VD Lohot
2.	1.1.049	Integrated nutrient management and vegetative propagation technique for quick establishment of *Kusum* (*Schleichera oleosa* (Lour.) Oken).	Dr. S Ghosal
3.	1.1.056	Development and evaluation of lac production practices for *swadi palas* for productivity and two bushy hosts--*arhar* and *semialata* for summer sustainability.	Dr. J Ghosh
4.	1.1.064	Identification and cloning of putative key genes involved in terpene biosynthesis of the Indian lac insect, *Kerria lacca* (Kerr).	Dr. Thamilarasi K
Core Program – II : Crop Production System Management			
5.	1.1.047	Tritrophic interaction in lac ecosystem.	Dr. A Mohanasundaram
6.	1.1.048	Carbon sequestration under different lac host based land use systems.	Dr. SS Bhat
7.	1.1.057	Management of stem canker disease of *Flemingia semialata*, a commercial lac host.	Dr. AK Singh
8.	1.1.058	Lac Integrated Farming System-Phase II.	Dr. SS Bhat
9.	1.1.059	Effect of abiotic factors on lac associated fauna in *rangeeni* crops.	Dr. Md Monobrullah, till November, 2016 Dr. A Mohanasundaram since December, 2016
Core Program – III : Processing, Storage and Quality Management			
10.	1.2.060	Development of pilot-plant of dewaxed decolourized lac (DDL) for training, demonstration and process refinement.	Er. SK Pandey
11.	1.2.061	Control of deacetylation in gum *karaya* on storage for quality retention.	Dr. S Srivastava
12.	1.2.066	Biodegradation studies on lac resin using soil burial method processing.	Dr. PC Sarkar
Core Program – IV : Value Addition, Application Development and Product Diversification			
13.	1.2.062	Synthesis and evaluation of cross-linked *guar* gum hydrogels for application in bio-remediation and in agriculture.	Sri N Thombare
14.	1.2.063	Green synthesis of silver nanoparticles capped in *acacia* and *jhingan* gum for bactericidal application.	Dr. MZ Siddiqui
15.	1.2.065	Development of coating formulation for paper packaging materials.	Dr. MF Ansari

S. No.	Project No.	Title of the Project	Principal Investigator
16.	1.2.067	Modification of *guar* and *arabic* gum for potential use as dietary fibre.	Dr. AR Chowdhury
17.	1.2.068	Natural gum based adsorbents for removal of heavy metals from water.	Sri Mohd Ali
Core Program – V: Capacity Building of Farmers and Entrepreneurship Development			
18.	1.3.037	Learning, capacity building, extension education and information service on natural resins and gums.	Dr. AK Jaiswal
Core Program – VI: Technology Evaluation, Refinement, Dissemination and Demonstration			
19.	1.3.038	Development and validation of IPM modules for the management of predators and parasitoids associated with lac insect, *Kerria lacca* (Kerr).	Dr. AK Jaiswal
20.	1.3.042	Evaluation of lac mud as organic manure.	Dr. AK Singh
21.	1.3.043	Impact assessment of technological interventions and market research on natural resins and gums (NRGs).	Dr. RK Yogi
22.	1.3.050	Information & Communication Technology (ICT) intervention on natural resins and gums knowledge dissemination system.	Dr. Alok Kumar till September, 2016 Dr. AK Singh since October, 2016
23.	1.3.051	Standardization of package of practices for *rangeeni* lac cultivation on *Flemingia semialata*.	Dr. AK Singh
Network Projects (ICAR, New Delhi sponsored)			
24.	3.2.026	Network Project on Harvesting, processing and value addition of natural resins and gums.	Dr. N Prasad, PC
	3.2.026.01	Field guide for identification of major resin and gum producing plants.	Sri N Thombare
	3.2.026.02	Development and antibacterial activity of *Buchanania lanzan* (*piyar*) gum-based silver nanoparticles.	Dr. MZ Siddiqui
25.	3.1.054	Network Project on Conservation of lac insect genetic resources.	Dr. Md Monobrullah, PC till November, 2016. Dr. KK Sharma, PC since December, 2016.
	3.1.054.01	Elemental budgeting of lac production system in *Flemingia semialata* for sustainable lac insect-host plant eco-system.	Dr. Anees K
26.	3.3.066	Network Project on High value compounds and phytochemicals.	Dr. SKS Yadav
Externally Funded Project			
27.	2.3.039 (Jharkhand Govt. Sponsored)	Lac cultivation and processing unit establishment.	Dr. AK Singh

Publication and Publicity

Publications

Research papers

- Ansari MF and Kumari N (2016). Modification of shellac with melamine and epoxy resins. *Asia Pacific Coatings Journal* 29(2): 27-30.
- Bhat SS, Singh NB, Sankhyan HP and Sharma KR (2016). Genetic variability for growth traits of different half-sib progenies of *Pinus roxburghii Sargent*. *Ind. J. Ecol.* 43(2): 765-769.
- Bhat SS, Singh NB, Sankhyan HP and Sharma KR (2016). Variability studies for needle and wood traits of different half sib progenies of *Pinus roxburghii Sargent*. *Physiol. Molecular Biol. Plants* 22(2):231–239 (DOI 10.1007/s12298-016-0358-y).
- Binsi PK, Nayak N, Sarkar PC, Jeyakumar A, Ashraf PM, Ninan G, Ravishankar CN (2016). Structural and oxidative stabilization of spray dried fish oil microencapsulates with gum *arabic* and sage polyphenols: Characterisation and release kinetics, *Food Chem*. 219:158-168. Digital version at: http://dx.doi.org/10.1016/j.foodchem.2016.09.126.
- Chhaya, Prasad N, Pawar VS and Jadhav BA. (2016). Utilization of *guar* and *arabic* gum blend in food products. *Food Process Engineering and Technology*, 437-448.
- Dubey S, Sinha DK, Murugan MS, Singh PL, Siddiqui MZ, Prasad N, Prasanna VA, Bhardwaj M and Singh BR (2015). Antimicrobial activity of ethanolic and aqueous extracts of common edible gums against pathogenic bacteria of animal and human health significance. Research & Reviews: *J. Pharmaceutics Nanotechnol.* 3(3): 30-36.
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- Ghosh J, Lohot VD, Singhal V, Ghosal S and Sharma KK (2016). Morphological-biochemical-physiological traits assisted selection for *kusmi* lac production on *ber* (*Ziziphus mauritiana Lam.*) varieties. *Ind. J. Hort.* 73(1): 19-24.
- Jaiswal AK, Singh JP and Patamajhi P (2016). Toxicity of some novel insecticides against *Aprostocetus purpureus*, parasitoid of lac insect *Kerria lacca* (Kerr). *Ind. J. Entomol*. 78(4): 356-360.
- Kumar A, Jaiswal AK, Singh AK and Yogi RK (2015). Knowledge up-gradation of extension functionaries on non timber forest produces *i.e.* lac via Model Training Course. *J. Community Mobilization and Sustainable Development* 10(2): 199-205.
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- Monobrullah Md, Mohanasundaram A, Meena SC, Verma S and Sharma KK (2016). Host and location mediated variation in life cycle and biological attributes of Indian lac insect, *Kerria lacca* (Kerr). *Ind. J. Ecol*. 43 (Special issue-1), 169-172.
- Sharma SC, Prasad N, Pandey SK and Giri SK (2016). A review on status of gum tapping and scope for improvement. *Agri. Mechanization in Asia, Africa, and Latin America* 47 (3): 68 – 75.
- Sarkar PC, Sahu U, Binsi PK and Nayak N (2016). Effect of vegetables gums on proximate, functional, optical and sensory attributes of Catfish nuggets during chilled storage, *Asian J. Dairy & Food Res.* 35(2):130 – 136.
- Siddiqui MZ (2016). Diverse applications of oleo resins. *World J. Pharm. Sci*. 4 (10):1-3.
- Siddiqui MZ, Chowdhury AR, Thamilarasi K, Prasad N and Singh BR (2016). Amino acid profiling, viscosity and antibacterial activity of *acacia* gums from different locations in India. *World J. Pharm. Sci*. 4(11):165-171.
- Singh AK, Ghosal S and Jaiswal AK (2016). Effect of lac mud on fresh leaf yield of spinach. *Agrica* 5 (2): 148-151.
- Singh JP, Jaiswal AK and Monobrullah Md (2016). First Record of some pest insect on commercial lac host plant, *Ziziphus mauritiana* from India.

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- Swami S, Mishra SR, Saha S, Kaur C, Shabeer A, Oulkar D, Banerjee K, Singh N and Singh SB (2016). Ozonation for pesticide residue removal and its effect on ascorbic acid, lycopene, β-carotene and phenolic content in tomato (*Lycopersicon esculentum*) fruits. *Pesticide Research Journal* 28(1): 42-51.
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- Thamilarasi K, Mousam KR, Lohot VD, Mohanasundaram A, Ghosh J and Sharma KK (2016). Genetic diversity analysis of *palas* (*Butea monosperma* (Lam.) Taub.) flower variants through Random Amplified Polymorphic DNA. *Ind. J. Plant Genetic Resources* 29(2): 187-193 (DOI 10.5958/0976-1926.2016.00027.9).
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- Yogi RK, Kumar A, Siddiqui MZ, Thombare N, Meena GL and Vedamurthy KB (2016). Nutritional properties of the under-exploited Non-Wood Forest Products (NWFPs) and potential to supplement Indian diet: An empirical analysis. *Agri. Economics Res. Review* 29 (24): 199.
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Papers presented/contributed in conferences/ symposia/seminars

- Following papers were presented in International Conference on Natural Resources Management – An Ecological perspective, SKUAST-Jammu, February 18-20, 2016:
  - Anees K and Monobrullah Md (2016). *Rangeeni* lac insect (*Kerria lacca*) survival and its dependence on biochemical profile of *ber* (*Ziziphus mauritiana*) during summer crop, p. 775.
  - Ghosh J, Lohot VD, Ghosal S and Singhal V (2016). Fruit *ber* varieties for winter *kusmi* lac production, livelihood opportunities for lac growers in Jharkhand, p. 381-382.
  - Mohanasundaram A, Monobrullah Md, Sharma KK, Meena SC, Verma S and Ramani R (2016). *Aprostocetus purpureus*, a major parasitoid of Indian lac insect, *Kerria lacca* (*Coccoidea: Tachardiidae*), p. 217-218.
  - Monobrullah Md, Mohanasundaram A, Meena SC, Verma S and Sharma KK (2016). Host and location mediated variation in life cycle and biological attributes of Indian lac insect, *Kerria lacca* (Kerr), p. 310.
  - Siddiqui MZ, Chowdhury AR and Ali M (2016). Polysaccharides: Potential source for silver nanoparticles synthesis, p. 442.
  - Thamilarasi K, Vinay KM, Toppo NN, Ranjan SK, Mohanasundaram A, Sharma KK and Ramani R (2016). Genetic association of lac insect (genus: *Kerria*) genotypes using EST-Microsatellite markers, p. 857.
- Following papers were presented in 18th Indian Agricultural Scientist and Farmer's Congress on Prospects of Skill Development in Agriculture and Rural Development - A step towards make in India, Bioved Research Institute of Agriculture and Technology, Allahabad, February 20-21, 2016:
  - Yogi RK, Kumar A and Jaiswal AK (2016). Impact assessment of skill development in lac cultivation and future prospects, p. 5.
  - Kumar A, Yogi RK, Jaiswal AK and Singh AK (2016). Evaluation of project on lac cultivation processing in the Balod divisional forest area of Chhattisgarh under *Swarnjayanti Gram Swarojgar Yojna* (SGSY), p. 24.
  - Jaiswal AK (2016). Novaleuran: An effective insect growth regulator to reduce biotic stress in lac cultivation, p. 64.
  - Singh AK, Ghosal S and Jaiswal AK (2016). Manurial value of lac mud and its effect on performance of brinjal (*Solanum melongena*), p. 64-65.
- Ghosh J, Lohot VD, Ghosal S, Singhal V and Sinha NK (2016). Drought resilient *Flemingia semialata* for improving lac productivity for drought prone ecologies. National Seminar on Innovative

Breeding Approaches for Agricultural Security, ISGPB-BAU, Ranchi, March 13-14, p. 64.

- Following papers were presented in International Conference on Chemical Engineering and Advanced Polymeric Materials, BIT, Mesra, Ranchi, August 18-20, 2016:
  - Ansari MF and Prassad N (2016). Natural coating on paper packaging materials, p. 76.
  - Chowdhury AR, Thombare N and Srivastava S (2016). Synthesis and Chracterization of cationic derivative of *guar* gum, p. 125-126.
  - Mate Ch. J and Thombare N (2016). *Jhingan* gum : A promising food additive, p. 81-82.
  - Sarkar PC and Ansari MF (2016). Application of lac resin-based coating formulations for extending post harvest life of ginger, p. 84-85.
  - Siddiqui MZ, Chowdhury AR and Ali M (2016). Synthesis of *acacia* gum-based nano formulations, p. 38-39.
  - Srivastava S, Chowdhury AR, Walia S and Saha S (2016). Plant growth promotion activity of lac wax policosanol, p. 124-125.
  - Swami S and Singh SB (2016). Ozonation for pesticide removal from capsicum fruits and its effect on nutritional quality, p. 78-79.
  - Thombare N, Jha U, Mishra S and Siddiqui MZ (2016). Cross-linked *guar* gum hydrogels for environmental remediation, p. 82-83.
- Following papers were presented in National Meet of Entomologists, ICAR-IIHR, Bengaluru, October 7-8, 2016:
  - Mohanasundaram A and Sharma KK (2016). Current status and importance of faunal bio-diversity of lac insect in India, p. 34.
  - Monobrullah Md, Mohanasundaram A, Sharma KK and Anees K (2016). Climate change and lac crop performance, p. 86.
- Following papers were presented in National Symposium on Agrochemicals Research and Education in India: Appraisal and Road Map for Future, Division of Agricultural Chemicals, ICAR-IARI, New Delhi, November 15-17, 2016:
  - Chowdhury AR, Srivastava S and Sudarshan M (2016). Antifungal evaluation of anthraquinone lac dye on some phtyotopathogenic fungi, p. 100.
  - Mate Ch. J and Thombare N (2016). Physico-chemical study of unexplored *jhingan* gum, p. 98.
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- Lohot VD, Thamilarasi K, Ghosh J, Mohanasundaram A and Sharma KK (2016). Monograph on *palas*, *Butea monosperma* (Lam.) Taubert. ICAR-IINRG, Ranchi, 1-111pp.
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- Prasad N and Nath A (2016). Processing of natural resins and gums – An overview (Sharma KK, Monobrullah Md, Mohanasundaram A

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- Sharma SC, Tewari JC, Prasad N, Pandey SK and Kar Amit K (2016). Manual on gum inducer technique for gum tapping from *Acacia senegal*. Technical Bulletin No. 15/2016, ICAR-IINRG, Ranchi, 1-27 pp.
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- Singh SC, Singh AK, Yadav SP, Yadav SK and Sharma BL (2015). Effect of micorrhiza (VAM) on productivity and profitability of sugarcane. *Agrica* 4:130-132.
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- Following popular articles were published in Laksha, 2016 (ISSN No. 2454-7840), ICAR-IINRG, Ranchi, 104 p.:
  - ज्योतिर्मय घोष, वैभव डी लोहोट, विभा सिंघल एवं सौमेन घोषाल। फलदार पेड़ के प्रभेदों पर लाख की खेती, पृष्ठ 1-3।
  - निरंजन प्रसाद, छाया एवं अमित कुमार कर। अरबी गोंदः परिचय एवं मूल्यवर्द्धन, पृष्ठ 4-8।
  - महताब ज़ाकरा सिद्दीक़ी। प्राकृतिक गोंदः सामाजिक एवं आर्थिक पहलू, पृष्ठ 9-11।
  - राजकुमार योगी, आलोक कुमार एवं नंदकिशोर ठोंबरे। भारत में कराया गोंदः उत्पादन, मूल्यवर्द्धन एवं निर्यात, वर्तमान स्थिति तथा संभावनाएं, पृष्ठ 12-14।
  - नंदकिशोर ठोंबरे, वैभव डी लोहोट, राजकुमार योगी एवं निरंजन प्रसाद। डिकामालीः बहुपयोगी औषधीय राल की संकट ग्रस्त प्रजाति। पृष्ठ 15-17।
  - संजय श्रीवास्तव एवं अर्णव राय चौधुरी। लाख मोम पोलिकोसानोलः एक बहुपयोगी मिश्रण, पृष्ठ 18-19।
  - राजकुमार योगी, आलोक कुमार, अजय कुमार सिंह, अनिल कुमार जायसवाल, मदन मोहन, मनोज कुमार एवं जयदेव महतो। बंगाल में लाख उत्पादनः वर्तमान स्थिति एवं संभावनाएं, पृष्ठ 20-23।
  - अर्णव राय चौधुरी एवं संजय श्रीवास्तव। प्रयोगशाला में सुरक्षा संबंधी आवश्यकताएं, पृष्ठ 24-26।
  - अजय कुमार सिंह, आलोक कुमार, राजकुमार योगी एवं अनिल कुमार जायसवाल। भूमिगत जलः संचयन एवं कम पानी की सिंचाई पद्धतियां, पृष्ठ 27-29।
  - सतीश चन्द्र शर्मा, संजय कुमार पाण्डेय, निरंजन प्रसाद एवं अमित कुमार कर। रीपरः खड़ी फसल कटाई मशीन, पृष्ठ 32-36।
  - सतीश चन्द्र शर्मा, संजय कुमार पाण्डेय, निरंजन प्रसाद एवं अमित कुमार कर। लघुस्तरीय समेकित लाख प्रसंस्करण ईकाई, पृष्ठ 37-41।
  - सतीश चन्द्र शर्मा, संजय कुमार पाण्डेय, निरंजन प्रसाद, एवं अमित कुमार कर। जीरोटिल फर्टीसीड-ड्रिलः बिना जुताई गेहूँ की बुवाई, पृष्ठ 42-47।
  - आलोक कुमार, राजकुमार योगी एवं अजय कुमार सिंह। प्रधानमंत्री फसल बीमा योजना, पृष्ठ 48-49।

- विनय कुमार मिश्रा, तमिलरसी के एवं केवल कृष्ण शर्मा। कृषि के उन्नयन में जैव-प्रौद्योगिकी की उपयोगिता, पृष्ठ 50-53।
- आलोक कुमार, अनिल कुमार जायसवाल, अजय कुमार सिंह एवं राजकुमार योगी। लाख प्रसार गतिविधियां, पृष्ठ 65-67।
- अजय कुमार सिंह, आलोक कुमार, राजकुमार योगी एवं अनिल कुमार जायसवाल। मिट्टी की जाँचः क्यों और कैसे, पृष्ठ 68-69।
- सौरभ स्वामी। फल एवं सब्जियों से पीड़क नाशियों के अवशेष कम करने के घरेलु उपाय, पृष्ठ 70-72।
- आलोक कुमार, राजकुमार योगी, अजय कुमार सिंह एवं अनिल कुमार जायसवाल। कृषि एवं ग्रामीण विकास में प्रसार शिक्षा तथा किसान, पृष्ठ 73-75।
- राजकुमार योगी, महताब ज़ाकरा सिद्दीकी, अर्णव राय चौधुरी एवं आलोक कुमार। मेरा गाँव-मेरा गौरवः एक कदम प्रगति की ओर, पृष्ठ 76-77।
- अंजेश कुमार एवं महताब ज़ाकरा सिद्दीकी। फादर कामिल बुल्केः एक अनन्य हिन्दी सेवी, पृष्ठ 78-80।
- महताब ज़ाकरा सिद्दीकी। साम्प्रदायिकताः एक अति गम्भीर राष्ट्र विध्वंसक व्याधि, पृष्ठ 81-82।
- महताब ज़ाकरा सिद्दीकी एवं अंजेश कुमार। वर्ष 2015-16 में अनुसंधान की उपलब्धियां, पृष्ठ 89-94।

❋ महताब ज़ाकरा सिद्दीकी (2016)। प्राकृतिक गोंद की गुणवत्ता के उभरते आयाम। कृषक वन्दना, नवम्बर, अंक 12, पृष्ठ 22-24।

❋ Singhal V, Ghosh J and Bhat SS (2016). Isoprene emission from bioenergy plantations---Serious concern of global warming. Indian Farmer 3(12): 874-880

Institute Publications

❋ Beneficial Insect Farming – Benefits and Livelihood Generation, 1-194 pp.

❋ Monograph on *Palas, Butea monosperma* (Lam.) Taubert, 1-111pp.

❋ ICAR-IINRG: At a Glance, Folder, 12 p.

❋ Laksha, Rajbhasha Patrika, 1-104 pp.

❋ Impact assessment report (Consultancy project) on Sustainable income generation through scientific lac cultivation, Consultancy Report, 1-100 pp.

❋ Natural resins and gums: Agribusiness modules for skill and entrepreneurship development, Training Manual, 1-144 pp.

❋ Lac insect and associated fauna – A Practical Manual. Technical Bulletin, 1-42 pp.

❋ Manual on gum inducer technique for gum tapping from *Acacia senegal*, Technical Bulletin, 1-27 pp.

❋ Model bankable projects: Lac cultivation for livelihood security, Booklet, 1-34 pp.

Publicity

Tours/ Visits

❋ Singh AK, Sr. Sc. visited Assam and Nagaland for crop monitoring of winter season *kusmi* lac crop (*aghani*) growing on *ber* trees being undertaken by TRIFED, Assam, January 3-6, 2016.

❋ Sarkar PC, Pr. Sc. visited CIFT, Cochin and CPCRI, Kayamkulam Center in connection with on-going project on fish technology (CIFT) and proposed project on mite control in coconut (CPCRI), January 12-19, 2016.

❋ Pandey SK, Sc. visited M/s National Enterprise, Ancillary area, Tupudana, Hatia w.r.t. inspection of Small Scale Lac Processing Unit (Cap-100 kg/ day) of JASCOLAMPF, January 14, 2016.

❋ Pandey SK, Sc. and Sharma SC, Sc. visited M/s Engineers & Engineers, Ancillary area, Tupudana, Hatia w.r.t. inspection of Small Scale Lac Processing Unit (Cap-100 kg/day) of JASCOLAMPF, February 23 and March 09, 2016.

❋ Ghosal S, Pr. Sc. visited Mangubandh and briefed villagers about factors affecting crop production in the practical field condition, February 29, 2016.

❋ Mohanasundaram A, Sc. visited, interacted and provided technical advice to farmers under *Mera Gaon Mera Gaurav* (MGMG) programme at Deogain, March 11, 2016.

❋ Yogi RK, Sc. visited NRG based Industries and emerging lac growing areas of Uttara Kannara district and Bangalore in Karnataka State and interacted with the stakeholders and resource persons, March 11-17, 2016.

❋ Anees K, Sc. visited Kharsidagh village as part of the 'MGMG' programme and motivated farmers for better farming practices, March 21, 2016.

- Ghosal S, Pr. Sc. visited Mangubandh and briefed villagers about basics of crop production in the practical field condition, March 31, 2016.
- Sharma SC, Sc. visited Kankebar, Ramgarh to explore the possibility of gum tapping from *karaya, ghatti* and *gijan* trees and demonstrated scientific method of gum tapping through gum inducer technology, April 01, 2016.
- Ghosal S, Pr. Sc. visited Mangubandh under 'MGMG' programme and briefed villagers about basics of health management, April 27, 2016
- Yogi RK, Sc. and Thombare N, Sc. conducted Central India tour covering parts of Chhattisgarh, Madhya Pradesh, Maharashtra and Telangana. During these survey photographs of gum-resin producing plant parts were taken, linkages with gum tapping farmers and suppliers/ dealers were established and farmers were encouraged to used gum inducer and modern tapping techniques. Two success stories were documented and two field demonstrations were also conducted, May 2-9, 2016.
- Mohanasundaram A, Sc. visited, interacted and provided technical advice to farmers under 'MGMG' programme at Deogain, May 05 and 18, 2016.
- Anees K, Sc. visited SFRI, Jabalpur and MPUAT, Udaipur to monitor the progress of the research work under NP-CLIGR, May 9-15, 2016.
- Mohanasundaram A, Sc. visited PJTSAU, Hyderabad and KFRI, Thrissur to monitor the progress of the research work under NP-CLIGR, May 9-17, 2016.
- Siddiqui MZ, Pr. Sc.; Yogi RK, Sc. and Chowdhury AR, Sc. conducted field visits on various locations of Khunti district to interact stakeholders and two field visits at Jaradih village, Ranchi under 'MGMG' programme, May 16, 2016.
- Yogi RK, Sc. visited Dhanbad, Girdih, Bokaro, Ramgarh, Khunti and Ranchi (Jharkhand); Delhi; Dehradun (Uttarakhand); Surat, Vadodara, Anand, Baruch & Navsari (Gujarat) and Jaipur, Sikar and Ajmer (Rajasthan) and interacted with the traditional bangle makers, Forest Departments, Directorate of Economics and Statistics, Departments of Agriculture, NIAM, local markets and industrial areas for data collection on NRGs from gum processing factories, gum traders and other stakeholders, May 16 – June 10, 2016.
- Sharma SC, Sc. visited Sarjandih village for generating cleaning awareness and also lac cultivation amongst villagers under 'MGMG', May 17 and 30, 2016.
- Ghosal S, Pr. Sc. visited Mangubandh village and briefed the importance of cleanliness, science *vis-a-vis* superstition and general hygiene for health to the villagers under 'MGMG' programme, May 23, 2016.
- Bhat SS, Sc. visited ICAR-RCER RC Palandu and Birsa Agricultural University regarding varietal selection of different crops for the summer season, to be evaluated in the LIFS project with *semialata*, May 31, 2016.
- Sharma SC and Thombare N, Sc. visited Ramgarh for inspection of gum tapping and exudation on *karaya* trees (*Sterculia urens*), June 01, 2016.
- Thombare N, Sc. visited Taimara valley for observation and collection of gum samples exudated from ethephon injected trees, June 02, 2016.
- Ansari MF, Sr. Sc.; Singh AK, Sr. Sc. and Yadav SKS, Sc. visited Beradih, Gutidih and Jaradih villages, Ranchi under 'MGMG' programme for motivation of farmers for scientific lac cultivation and organized a *Kisan Gosthi* on lac cultivation, June 4, 2016.
- Bhat SS, Sc. visited Baridih, Itki, Ranchi for demonstration of LIFS at field of Md. Sadiq Ahmad, June 06, 2016.
- Bhat SS, Sc. visited ICAR-RCER RC Palandu discussed with horticulturists about the suitable fruit crops for hoti-lac system, in place of *amla* and lemon, June 07, 2016.
- Sharma SC, Sc. visited Jharkhand State Co-operative Lac Marketing and Procurement Federation, Ranchi regarding video film preparation under the project entitled, 'Information and Communication Technology (ICT) intervention on natural resins and gums knowledge dissemination system', June 17, 2016.
- Bhat SS, Sc. visited BAU Kanke, Ranchi for procurement of ginger Bardwan variety for LIFS model development, June 20, 2016.

- Bhat SS, Sc. visited Buteo, Deogain, Ranchi for demonstration of LIFS at farmers' fields and interacted with farmers, June 27, 2016.
- Ansari MF, Sr. Sc.; Singh AK, Sr. Sc. and Yadav SKS, Sc. visited Beradih village under 'MGMG' programme and demonstrated the pre-treatment of broodlac before planting on trees in the village (Live telecast of the demonstration and experts' comments was aired on television by ETV-Bihar Jharkhand on July 22), July 02, 2016.
- Sharma SC, Sc. alongwith Agarwal KN, Pr. Sc., ICAR – CIAE, Bhopal regarding feedback from the firm for manufacturing and sale of agricultural equipments/machineries under the MOU signed with ICAR–CIAE, Bhopal visited Krishi Gram Vikas Kendra (KGVK) Agro Ltd, Rukka Village, Ranchi (a subsidiary of USHA Martin Agro Ltd, Tatisilwai, Ranchi), July 02, 2016.
- Pandey SK, Sc. visited Beradih village and 60 kg of broodlac (*rangeeni*) was distributed to 30 farmers (approx.) under 'MGMG', July 08, 2016.
- Ansari MF, Sr. Sc. visited Jaisawal Shellac Factory, Balrampur (West Bengal) and discussed with Sri Navin Jaisawal about production of aleuritic acid, its purity and quality, July 22, 2016.
- Ghosal S, Pr. Sc. visited Deogain for application of fertilizers under result demonstration programme at farmers' field, July 28, 2016.
- Ghosal S, Pr. Sc. visited Mangubandh village under the 'MGMG' programme for the demonstration of fertilizer application on *ber* for winter season *kusmi* lac production, July 29, 2016.
- Singh AK, Sr. Sc.; Kumar A, Sr. Sc.; Yogi RK, Sc.; Singh DK, STO; Patamajhi P, STO and Madan Mohan, TA visited various villages of Jashpur, Surguja, Surajpur, Korea, Narayanpur, Bhanupratpapur (East and West), Dhamtari, Gariyaband Bijapur, Sukma, Jagdalpur, Dantewada and Manendragarh forest divisions of Chhattisgarh for survey and impact assessment of consultancy project under *Swarn Jayanti Gram Swarojgar Yojna* Special project of Chhattisgarh Government, August 8-14, 2016.
- Siddiqui MZ, Pr. Sc.; Yogi RK, Sc., Chowdhury AR, Sc. visited Jaradih village and distributed 150 *ber* (*Ziziphus mauritiana*) saplings amongst the farmers for planting in the fields. Ms Sandhya Mundu, BDO, Angarah Block also accompanied and participated in the distribution of the saplings under 'MGMG' programme, August 10, 2016.
- Ghosh J, Sr. Sc.; Mohanasundaram A, Sc. and Bhat SS, Sc. visited and provided technical advice to farmers about *phunki* removal, thinning of excess lac insects and spraying details under 'MGMG' programme at Deogain village, August 19, 2016.
- Thombare N, Sc. visited Taimara valley for collection of seedlings of the *Jhingan* (*Lannea coromandelica*) and *Piyar* (*Buchanania lanzan*) on August 26, 2016.
- Ghosh J, Sr. Sc.; Mohanasundaram A, Sc. and Bhat SS, Sc. have adopted additional village Sodha, Khunti under 'MGMG' programme. Meeting was convened with farmers and discussed general issues and agricultural activities *viz*., scientific lac cultivation, improved cereal and vegetable varieties, pest & disease management and integrated farming system etc., at Sodha, Khunti, August 28, 2016.
- Thombare N, Sc. visited Pataratu valley for collection of Dikamali (*Gardenia gummifera*) resin and cuttings for planting at Institute's nursery, August 29, 2016.
- Jaiswal AK, Pr. Sc. and Yogi RK, Sc. visited Ranchi's adjoining areas to monitor and crop estimate for *aghani* crop, September 21, 2016.
- Yadav SKS, Sc. visited lac industries in Balarampur, Purulia (West Bengal) to strengthen liaisoning and identification of problems of lac industry, September 22, 2016.
- Jaiswal AK, Pr. Sc. and Yogi RK, Sc. visited lac production area in Assam along with representative of Missing Autonomous Council (MAC) to monitor and demonstrate lac cultivation at three places, an aleuritic acid plant (M/s KD Udyog) and ICAR-NDRI Kalyani Centre, September 27-29, 2016.
- Ghosal S, Pr. Sc. visited and delivered a lecture for observing *swachhta pakhwada* at Mangubandh village, October 18, 2016.
- Ghosal S, Pr. Sc. visited the demonstration plot of RK Mission located at Gatelsud farm for monitoring tree health, lac crop and promoting

clean agriculture (*swachh krishi*) under technology popularization programme, October 19, 2016.

- Ghosh J, Sr. Sc.; Mohanasundaram A, Sc. and Bhat SS, Sc. visited Sodha village, Khunti district and created awareness, under 'MGMG' programme, about cleanliness in the village and also sensitized students of Government Primary School, October 21, 2016.
- Siddiqui MZ, Pr. Sc. visited Centre for Performing Arts, Central University of Jharkhand, Brambe, Ranchi, November 22, 2016.
- Yogi RK, Sc. and Patamajhi P, STO visited Jharkhand (2 districts) and Chhattisgarh (5 districts) to conduct survey for impact assessment (consultancy project) under *Swarn Jayanti Gram Swarojgar Yojna* Special project of Chhattisgarh Government, November 28-December 3, 2016.
- Jaiswal AK, Pr. Sc. and Yadav SKS, Sc. visited Gutidih village under 'MGMG' programme to commemorate the Agriculture Education Day, monitoring of field demonstrations and interaction with villagers on scientific lac cultivation, November 30, 2016.
- Ansari MF, Sr. Sc.; Singh AK, Sr. Sc. and Yadav SKS, Sc. visited Beradih, village under 'MGMG' programme, to commemorate the Agriculture Education Day, monitoring of field demonstrations and interaction with villagers on scientific lac cultivation, December 3, 2016.
- Ghosal S, Pr. Sc. visited Mangubandh village to commemorate Soil Health Day under 'MGMG' programme. Beneficiary farmers were briefed about importance of fertilizer application for *kusmi* lac production on *ber*, December 05, 2016.
- Sharma SC, Sc. visited Sarjandih village to discuss importance of soil health on cultivation aspect, management of nutrients in the soil and related issues on World Soil Day under 'MGMG' programme, December 05, 2016.
- Siddiqui MZ, Pr. Sc. and Chowdhury AR, Sc. visited Jaradih village on the occasion of World Soil Day. Soil samples of farmers' fields were checked and it was found that the pH of most of the soil samples was acidic, needing lime treatment. Farmers were also briefed about the method of preparing compost manure and FYM in proper way and dose and time of application in the field under 'MGMG' programme, December 05, 2016.
- Siddiqui MZ, Pr. Sc. visited CIF, Department of Pharmaceutical Sciences and Department of Chemistry, BIT, Mesra, Ranchi, on March 11 & 22, April 18, August 01 & 04, October 03 and November 09, 2016, for analyzing samples.
- Bhat SS, Sc. visited Pater, Deoghai, Goasaitoli, Kharsidagh, Manghobandh, Sodha villages from time to time, regarding LIFS demonstration and evaluation during the year, 2016.
- Bhat SS, Sc. visited Deogain village under 'MGMG' programme and interacted with different farmers at least once every month during the year, 2016.
- Thombare N, Sc. under 'MGMG' programme, visited Putadag village several times and conducted a number of meetings with the farmers and explained the importance of soil sampling and scientific procedure of lac cultivation, during the year, 2016.

Data base

- National level database of the NRGs production and EXIM data have been generated and maintained at NRG Information Cell (NIC), TOT Division, ICAR-IINRG, Ranchi.

Radio/ TV Talks

Expert	Topics	Date of Recording/ Broadcast/Telecast
Radio talk		
Dr. S Ghosal, Pr. Sc.	*Ber aur semialata par sheetkalin kusmi lakh katai me savdhanian aur uski bhandaran.*	06.01.2016
Dr. S Ghosal, Pr. Sc.	*Kusum vriksha par kusmi lakh ka sancharan.*	15.02.2016
Dr. S Ghosal, Pr. Sc.	*Semialata poudha me grismakalin lakh utpadan me savdhania for aaj ki baat programme.*	18.5.2016
Dr. J Ghosh, Sr. Sc.	*Ber praved par lah ki kheti*	17.9.2016
Dr. S Ghosal, Pr. Sc.	*Kusmi lakh phasal ki samayik vishoyon par jankari.*	24.12.2016
TV talk		
Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division	Protection of lac crop from enemy insect.	04.02.2016
Dr. KK Sharma, Director	*Lakh utpadakon ke liye kaliankari yojnayen aur sansthan ki pahal* .	16.3.2016
Dr. KK Sharma, Director	*Rangeeni lakh poshak vrikshon ki katai chhantai.*	28.3. 2016
Dr. KK Sharma, Director	*Lah prasanskaran kar kisan kaise adhik labh kamayen.*	26.5. 2016
Dr. AK Singh, Sr. Sc. and Dr. SKS Yadav, Sc.	Method demonstration on dipping of *kusmi* broodlac with pesticides for inoculation on *ber.*	02.7.2016
Dr. KK Sharma, Director	*Barsat ke mausam mein kusmi lakh keet prabandhan.*	08.8.2016
Dr. KK Sharma, Director	*Lakh pate ki baat,* DD Kisan, New Delhi.	14.8.2016
Dr. KK Sharma, Director	*Kusmi lakh ki kheti.*	18.11.2016
Dr. RK Yogi, Sc.	Marketing aspects and employment generation potential of lac cultivation.	27.12.2016

Participation of Scientists in Conferences/Meetings/ Seminars/Symposia/Workshops/Trainings

By Director

- Participated in Scientific Advisory Committee Meeting of KVK, Mandu (Ramgarh), January 11, 2016.
- Chaired 74th Institute Joint Staff Council Meeting, January 12, 2016.
- Participated in Director's Conference, New Delhi, January 22-24, 2016.
- Chaired 3rd Coordination Committee Meeting of Network Project on Conservation of Lac Insect Genetic Resources (NP-CLIGR) as Project Coordinator organized by State Forest Research Institute, Jabalpur (Madhya Pradesh), January 28-29, 2016.
- Chaired meeting with Executive Engineer and other CPWD staff of Ranchi for expediting the civil work at the Institute, February 26, 2016.
- Participated in Programme Advisory Committee Meeting of DD Ranchi, March 08, 2016.
- Participated in DPC Meeting of ICAR-IIAB, Ranchi for clearance of probation of scientists, March 14, 2016.
- Participated in Scientific Advisory Committee Meeting of Divyayan KVK, Morahabadi, Ranchi, March 15, 2016.
- Participated in Scientific Advisory Committee Meeting of KVK, Bishunpur, Gumla, Ranchi, March 19, 2016.
- Coordinated the participation of ICAR Institutes in the Exhibition organized as a part of *Gram Uday se Bharat Uday Abhiyan* at Jamshedpur, April 23-24, 2016.
- Chaired the Institute Research Committee, April 27-28 and May 07, 2016.
- Participated in the Review Meeting of Directors and Project Coordinators of the Engineering Division with DDG (Engg.), New Delhi, May 10, 2016.
- Participated in the Meeting of Directors, VCs and the State Agricultural Officials of Bihar, Jharkhand, Odisha and West Bengal with DG, ICAR, at New Delhi, May 18, 2016.
- Participated in the Interface Meeting on Enhancing the Preparedness of Agricultural Contingencies for Jharkhand: Kharif 2016 organized by CRIDA, Hyderabad at Ranchi, May 24, 2016.
- Participated in the Steering Committee Meeting of Jharkhand (Second Green Revolution Programme), Ranchi, June 07, 2016.
- Participated in the Research Advisory Committee Meeting of Central Tasar Research and Training Institute, Nagri, Ranchi, June 09-10, 2016.
- Chaired the meeting with Jharkhand Tribal Development Officials for discussion on Tribal Empowerment and Livelihood Project, Ranchi, June 14, 2016.
- Convened & chaired the meeting with Director Agriculture and Director Horticulture (Jharkhand) in connection with discussion on ICAR-IINRG as Centre of Excellence on Lac, June 21, 2016.
- Participated in the First Steering Committee Meeting on Second Green Revolution as Special Invitee at ICAR-RCER, Patna, June 27, 2016.
- Coordinated the examination for recruitment of Technical (T-3), July 17, 2016.
- Participated in the India Today – The State of the State Conclave: Jharkhand, at Ranchi, July 23, 2016.
- Chaired the meeting with Auditors and Heads of Divisions and Sections in connection with ISO 9001:2008 certification, July 26, 2016.
- Chaired the Institute Senior Officers Committee Meeting, July 26, 2016.
- Chaired the Institute Management Committee, Meeting, August 24, 2016.
- Participated in the Review Meeting of Directors and Project Coordinators of the Engineering Division with DDG (Engg.), New Delhi, September 22, 2016.
- Chaired the 75th Institute Joint Staff Council Meeting, September, 2016.

- Participated in Programme Advisory Committee Meeting, DD Ranchi, September 23, 2016.
- Co-Chaired the 8th Coordination Committee meeting of Network Project on Harvesting, Processing and Value Addition of Natural Resins and Gums (NP-HPVA of NRG), organized by Kerala Agricultural University at Thrissur (Kerala), October 06-07, 2016.
- Chaired the General Body Meeting of the Society for Advancement of Natural Resins and Gums, Ranchi, October 19, 2016.
- Participated in a meeting with DG, ICAR and other Govt. Officials on IINRG as Centre of Excellence at New Delhi, October 25, 2016.
- Chaired the 76th Institute Joint Staff Council Meeting, December 20, 2016.
- Participated in the meeting of Directors and Project Coordinators of the Engineering Division with DDG (Engg.) on development of mobile app at New Delhi, December 27, 2016.

By Others

- Dr. AK Singh, Sr. Sc. participated in Training-cum-Workshop on New Paradigms of Soil Health Management, Birsa Agricultural University, Ranchi, January 18-20, 2016.
- Dr. Md Mnobrullah, Pr. Sc.; Dr. Anees K, Sc. and Dr. A Mohanasundaram, Sc. attended 3rd Co-ordination Committee Meeting of NP-CLIGR, State Forest Research Institute, Jabalpur, January 28-29, 2016.
- Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc. coordinated and attended Research-Extension-Farmers Interface Meeting-cum-Workshop, Torpa, Khunti, Ranchi, February 05, 2016.
- Dr. SC Sharma, Sc. attended meeting regarding tender opening and finalization of suppliers, Jharkhand State Co-operative Lac Marketing and Procurement Federation Limited, Ranchi, February 18, 2016.
- Dr. MF Ansari, Sr. Sc. and Dr. SKS Yadav, Sc. participated in National Workshop on Nanoscience and Nanotechnology (NWNSNT-2016), Pondicherry University, Puducherry, March 03-05, 2016.
- Dr. Anees K, Sc.; Dr. Thamilarasi K, Sc. and Dr. A Mohanasundaram, Sc. attended Workshop on Data Analysis by SPSS, Rajendra Institute of Medical Sciences, Ranchi, March 12, 2016.
- Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc. coordinated and attended Training-cum-Awareness Programme on Protection of Plant Varieties and Farmers' Right Act, 2001, Torpa, Khunti, Ranchi, March 29, 2016.
- Er. SK Pandey participated in Zonal Workshop-cum-Meet of NAIF Scheme, ZTMC, ICAR-CIAE, Bhopal, April 11-12, 2016.
- Dr. SC Sharma, Sc. organized and attended meeting regarding renewal of MOU of Small Scale Lac Processing Unit between ICAR – IINRG, Ranchi; M/s National Enterprises, Ranchi and M/s Engineers and Engineers, Ranchi, April 18, 2016.
- Dr. RK Yogi, Sc. attended 6th Meeting of the Pricing Cell to review Minimum Support Price for lac (*rangeeni* and *kusmi*) under the scheme of MSP for Non-Wood Forest Products, TRIFED, New Delhi, April 22, 2016.
- Dr. N Prasad, Pr. Sc. & Coordinator Network Project along with ADG(PE)/ADG(FE)/Directors/ PCs of AICRPs/PIs of NPs and CRPs participated in meeting chaired by DDG (Engineering), KAB –II, New Delhi, May 10, 2016.
- Dr. RK Yogi, Sc. coordinated and attended meeting with the Officials of TERI, New Delhi regarding cost of cultivation of various NTFPs for fixation of MSP, ICAR-IINRG, Ranchi, June 29, 2016.
- Dr. S Swami, Sc. participated in Workshop on Advanced Analytical Tools for Food Safety and Quality Testing organized by India section of Association of Analytical Chemists (AOAC), Gurgaon (Haryana), July 28 - 29, 2016.
- Dr. RK Yogi, Sc. participated in Seminar on Recent Trends in Agricultural Research Capacity, Investment and Outputs in India, NASC complex, New Delhi, August 17, 2016.
- Sri Mohd Ali, Sc. participated in an International Conference (ICEAPM-2016), BIT, Mesra, Ranchi, August 18-20, 2016.
- Dr. N Prasad, Pr. Sc. & Coordinator Network Project attended Review Meeting at Engineering SMD, ICAR, New Delhi, September 22, 2016.
- Dr. S Srivastava, Pr. Sc.; Dr. MZ Siddiqui, Pr. Sc.; Dr. AK Singh, Sr. Sc; Dr. MF Ansari, Sr. Sc; Er. SK Pandey, Sc.; Dr. SKS Yadav, Sc.; Dr. RK Yogi, Sc.; Dr. Thamilarasi K, Sc.; Dr. SC Sharma, Sc.; Dr. A Mohanasundaram, Sc.; Dr. AR Chowdhury, Sc.;

Sri N Thombare, Sc. participated in Workshop on Intellectual Property Rights (IPRs) in Agricultural Biotechnology, ICAR-IIAB, Ranchi, September 24, 2016.

- Dr. N Prasad, Pr. Sc. & Head, PPD Division; Dr. SC Sharma, Sc. and Dr. AR Chowdhury, Sc. participated in 8th Annual Workshop of Network Project on HPVA of NRG, Kerala Agricultural University, Thrissur (Kerala), October 06 – 07, 2016.
- Dr. RK Yogi, Sc. attended meeting regarding policy issues on Lac Cultivation and Processing in the Chair of the Tribal Commissioner, GOJ, Ranchi, October 10, 2016.
- Dr. AK Singh, Sr. Sc. attended Video Conferencing Address of Hon'ble Agriculture & Farmers Welfare Minister, GOI, for KVK Faculty, District Agriculture Officers of State Government, NIC, Khunti, Ranchi, October 19, 2016.
- Er. SK Pandey, Sc. participated in National Seminar on Creating Wealth from Waste and presented recovery of by-product lac dye, KVK, Sikohpur, Gurgaon (Haryana), October 27, 2016.
- Dr. PC Sarkar, Pr. Sc. and Dr. SC Sharma, Sc. attended 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products, New Delhi, November 07 - 11, 2016.
- Dr. VD Lohot, Sc.; Dr. Anees K, Sc.; Dr. Thamilarasi K, Sc. and Dr. A. Mohanasundaram, Sc. attended 4th Co-ordination Committee Meeting of NP-CLIGR, Assam Agricultural University, Jorhat (Assam), December 06-07, 2016.
- Dr. RK Yogi, Sc. participated in 24th Annual Conference on Agriculture for Nutritional Security, ICAR-IVRI, Izatnagar (Uttar Pradesh), December 15-17, 2016.
- Dr. N Prasad, Pr. Sc. & Coordinator Network Project attended meeting on Application Development, ICAR- IASRI, New Delhi, December 27, 2016.

Human Resource Development

- Dr. PC Sarkar, Pr. Sc. attended DST sponsored training on Science, Technology and Emerging Trends in Governance, Indian Institute of Public Administration, New Delhi, February 15–19, 2016.
- Dr. SC Sharma, Sc. attended ICAR sponsored 21 days Winter School on Manufacturing Technology of Agricultural Equipment, ICAR – CIAE, Bhopal, September 01-21, 2016.
- Dr. S Swami, Sc. and Sri Mohd Ali, Sc. attended ICAR sponsored Short Course on Synthesis and Characterization of Nano-materials for Agricultural Applications, ICAR-CIRCOT, Mumbai, September 19-28, 2016.
- Sri N Thombare, Sc. attended ICAR sponsored 21 days CAFT Training on Soil, Air and Water Pollution and Mitigation Strategies, Department of Soil Science, Punjab Agricultural University, Ludhiana (Punjab), November 02 – 22, 2016.
- Dr. A Mohanasundaram, Sc. and Dr. SS Bhat, Sc. attended ICAR sponsored 21 days Winter School on Application of Advanced Statistical Tools in Agricultural Research, Department of Agricultural Statistics, University of Agricultural Sciences, Dharwad (Karnataka), November 08-28, 2016.
- Dr. SS Bhat, Sc. attended International Training on Payments for Ecosystem Services: Concept, Theory and Practice, organized by ICRAF South Asia, ICAR-CAFRI, Jhansi, December 06-09, 2016.

Honours, Awards and Recognitions

By Director

- Dr. KK Sharma, Director co-chaired the Technical Session on Integrated Pest Management on February 19, 2016 in the International Conference on Natural Resource Management: Ecological Perspective, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, February 18-20, 2016.
- Dr. KK Sharma, Director was Chief Guest in IPR Workshop on Agricultural Biotechnology organized by Indian Institute of Agricultural Biotechnology, Ranchi, September 24, 2016.
- Dr. KK Sharma, Director was Guest of Honour in National Entomologists' Meet organized by Indian Institute of Horticultural Research, Bangalore, October 07-08, 2016.
- Dr. KK Sharma, Director was Chief Guest in Award Distribution Ceremony organized by Udyogini , an NGO, Ranchi, November 05, 2016.
- Dr. KK Sharma, Director was Guest of Honour in National Seminar on Maximum Happiness of the Greatest Numbers, the motto of Govt. policy, In

depth analysis organized by Chotnagpur Law College, Ranchi, November 19, 2016

- Dr. KK Sharma, Director, ICAR-IINRG was Chief Guest in Capacity Building Programme organized by the Jharkhand State Co-operative Lac Marketing & Procurement Federation Ltd., Ranchi, November 22, 2016.

By Others

- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Editorial Board, World Journal of Pharmaceutical Sciences, since January, 2013.
- Dr. MZ Siddiqui, Pr. Sc. reviewed a paper entitled, 'Chemical composition analysis of essential oil of *Isodon wightii* (Bentham) H. Hara' (Ms No. ID TEOP-2015-0409) for Journal of Essential Oil Bearing Plants, February 08, 2016.
- Dr. RK Yogi, Sc. was conferred the Best Oral Presentation Award for the paper entitled, 'Impact assessment of skill development in lac cultivation and future prospects', 18th Indian Agricultural Scientist and Farmer's Congress, Allahabad, February 20-21, 2016.
- Dr. A Mohanasundaram, Sc. was honoured as Reviewer, International Journal of Agriculture Sciences, March 03, 2016.
- Dr. J Ghosh, Sr. Sc. was honoured as External Expert Member of Research Advisory Committee under the discipline Forest Genetics, FRI University, Dehradun, since March 12, 2015.
- Dr. PC Sarkar, Pr. Sc. acted as External Expert for up-gradation of two JRFs to SRFs at Department of Pharmaceutical Sciences & Technology, BIT, Mesra, Ranchi, March 21, 2016.
- Dr. MZ Siddiqui, Pr. Sc. acted as Expert Member for selection of SRF under project titled, 'Evaluation of antiviral and anticancer potentials for lac exudates/dye', an Extra Mural Project, ICAR, New Delhi at Department of Pharmaceutical Sciences & Technology, BIT, Mesra, Ranchi, March 29, 2016.
- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Technical Editorial / Advisory Board of 'Krishak Vandana'---a highly reputed monthly Hindi Magazine on Agriculture & Farming, Jabalpur (Madhya Pradesh), since March, 2012.
- Dr. MZ Siddiqui, Pr. Sc. continued as Member, Editorial Board and Reviewer Research Journal of Chemistry and Environment, an International Monthly Online NAAS Indexed Journal, since June, 2014.
- Dr. N Prasad, Pr. Sc. & Head, PPD Division was elected as Fellow of The Institution of Engineers (India), Kolkata (West Bengal), July 02, 2016.
- Dr. AK Singh, Sr. Sc. was nominated as External Member of Board of Studies for Agronomy of VVS Purvanchal University, Jaunpur (Uttar Pradesh) for the period August, 2016 - August, 2018.
- Sri N Thombare, Sc. reviewed a paper entitled, 'Effect of periods of seed storage on seed quality characteristics of three soybean (Glycine max Merrill) varieties' for Sky Journal of Agricultural Research (SJAR), August 25, 2016.
- Dr. J Ghosh, Sr. Sc. was conferred Reviewer Excellence Award from Agricultural Research Communications Center, Karnal for Legume Research, September 05, 2016.
- Dr. Thamilarasi K, Sc. was awarded Distinguished Worker (Scientific Category) for the year 2016, ICAR-IINRG, Ranchi, September 20, 2016.
- Dr. MZ Siddiqui, Pr. Sc. reviewed a paper entitled, 'An overview of medicinal plants for potential cardio-protective activity' (Manuscript ID RJBT-2016-0234) for Research Journal of Biotechnology, September 30, 2016.
- Dr. MZ Siddiqui, Pr. Sc. bagged First Prize in Hindi Speech during Rajbhasha Celebrations, ICAR-IINRG, Ranchi, October 01, 2016.
- Dr. Anees K, Sc. bagged Second Prize in Hindi Essay Writing & Hindi Speech during Rajbhasha Celebrations, ICAR-IINRG, Ranchi, October 01, 2016.
- Dr. MZ Siddiqui, Pr. Sc. was elected Vice-President of Society for Advancement of Natural Resins & Gums (SANRAG), ICAR-IINRG, Ranchi, October 19, 2016.
- Dr. Anees K, Sc. was awarded Ph.D. degree from Department of Biochemical Engineering and Biotechnology, IIT Delhi for his work on 'Biosynthesis of aleuritic acid in Indian lac insect *Kerria lacca* and its *in vitro* production', November 6, 2016.
- Dr. S Ghosal, Pr. Sc. was conferred Reviewer Excellence Award from Agricultural Research Communications Center, Karnal, November 11, 2016.

- Sri ChJ Mate, Sc. and Sri N Thombare, Sc. were conferred Best Poster Award in National Symposium on Agrochemicals Research and Education in India: Appraisal and Road Map for Future, ICAR-Indian Agricultural Research Institute, New Delhi, November 15-17, 2016.
- Dr SS Bhat continued as reviewer of American International Journal of Research in Formal, Applied and Natural Sciences (AIJRFANS), Georgia, United States of America; http://iasir.net/aijrstemboardmembers.html, since November, 2013.
- Dr SS Bhat continued as reviewer of Canadian Journal of Plant Breeding, Ontario, Canada, since November, 2013.
- Sri N Thombare, Sc. reviewed a paper entitled, 'Preparation and evaluation of cosmetic adhesive containing *guar* gum' for Korean Journal of Chemical Engineering, December 03, 2016.
- Dr. PC Sarkar, Pr. Sc. was conferred Reviewer Excellence Award from Agricultural Research Communications Center, Karnal, December 28, 2016.
- Dr. SS Bhat, Sc. continued as Member, Editorial Team, Journal of Agricultural Science, Canadian Centre for Science and Education, Toronto, Canada; http://ccsenet.org/journal/index.php/jas/about/editorialTeam, since December, 2013.

Capacity Building/ Lectures/Talk Delivered

By Director

- Dr. KK Sharma, Director delivered a Keynote Lecture on Understanding the diversity in lac insects of Kerria spp in India and the nature of insect-host plant interaction, International Conference on Natural Resource Management: Ecological Perspective, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, February 18-20, 2016.
- Dr. KK Sharma, Director delivered an Invited Lecture on *Uchch Shiksha ka Badta Bazaar* on April 05, 2016 in 1st Statutory Conference of AIFRUCTO and Seminar on, 'Commercialization of Higher Education', Ranchi University, Ranchi, April 5-6, 2016.
- Dr. KK Sharma, Director delivered an Invited Lecture on, 'Mechanization Needs for Production and Processing of Natural Resins and Gums' in Academia-Industry Interaction Meet for Eastern Region organized by ICAR-CIAE, Bhopal at ICAR-RCER, Patna, June 28, 2016.

By Others

- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division; Dr. AK Singh, Sr. Sc.; Dr. SKS Yadav, Sc. and Dr. RK Yogi, Sc. delivered lectures in two days workshop on Recent advances on lac production, processing technologies and supply chain management system of NRGs, ICAR-IINRG, Ranchi, January 13-14, 2016.
- Dr. S Ghosal, Pr. Sc. addressed *Kisan Gosthi* on Soil health and interventions on scientific lac cultivation during Technology Fortnight, KVK, Jahajpur, Purulia (RKM), January 22, 2016.
- Dr. Thamilarasi K, Sc. guided five M.Sc. (Biotechnology) students from Marwari College, Ranchi on Cloning and expression profiling of prenyltransferase, a putative key gene in resin biosynthesis of the Indian lac insect, *Kerria lacca* (Kerr), January 27 – July 20, 2016.
- Dr. A Mohanasundaram, Sc. delivered a lecture-cum-demonstration on Lac insect life cycle, crop cycle and lac related terminology to Master Trainers, TOT Division, ICAR-IINRG, Ranchi, February 01, 2016.
- Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc. organized Research–Extension-Farmer's Interface Meeting-cum-Workshop on Lac Cultivation as Co-conveners under a collaborative project with Government of Jharkhand, Torpa, Khunti, Ranchi, February 05, 2016.
- Er. SK Pandey, Sc. imparted training on Lac dye to Sri Suraj Singhania, M/s Renshel Export Pvt. Ltd. Kolkata, February 06 – 15, 2016.
- Er. SK Pandey, Sc. imparted training on Dewaxed decolourised lac to Sri Vivek Agrawal, M/s Ganga Lac Factory, Khunti, Ranchi, February 08 – 14, 2016.
- Dr. MF Ansari, Sr. Sc. transferred the technology of Gasket shellac cement compound to M/s Alok Shellac Pvt Ltd, Balrampur (West Bengal), February 11-15, 2016.
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division delivered a lecture on Climate change and lac cultivation, KVK, West Singhbhum, February 16, 2016.

- Dr. SC Sharma, Sc. imparted training on Lac processing (preparation of seedlac from sticklac) to 10 participants from KVK, Rajnandgaon (Chhattisgarh), March 03 -05, 2016.
- Dr. S Swami, Sc. delivered a lecture on Isolation and identification of compounds from natural resins, PPD Division, ICAR-IINRG, Ranchi, March 19, 2016.
- Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc. delivered lectures on Awareness of farmers about Farmers' Right Act, 2001 in Training-cum-Awareness Programme on Protection of Plant Varieties and Farmers' Right Act, 2001, KVK, Khunti, Ranchi, March 29, 2016.
- Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc. participated and put up Institute stall to showcase the Institute technologies in *Kisan Mela on Pradhan Mantri Fasal Beema Yojna*, KVK, Khunti, Ranchi, April 13, 2016.
- Dr. PC Sarkar, Pr. Sc. delivered a lecture on Primary processing and value addition of lac to the participants of EDP Program organized by NIESBUD (Ministry of Skill Development, Govt of India), Ranchi Branch, Torpa, Khunti, Ranchi, April 19, 2016.
- Dr. AK Singh, Sr. Sc. participated and put up Institute stall to showcase the Institute technologies in Agricultural Exhibition on the occasion of *Gramodaya se Bharatuday* programme organized by ICAR HQ, JRD Tata Sports Complex, Jamshedpur, April 23-24, 2016.
- Dr. MF Ansari, Sr. Sc. transferred the technology of Water soluble lac to M/s JJ Sales, Ranchi, May 02-05, 2016.
- Dr. MZ Siddiqui, Pr. Sc. imparted training on Lac Wood Shine and Lac Glaze varnish to Sri Md Jawed, M/s JJ Sales, Ranchi and Sri Ajay Kumar, Durgapur (West Bengal), May 03-05, 2016 and July 26 – 27, 2016, respectively.
- Sri N Thombare, Sc. gave field demonstrations on Gum inducer technique for tapping of *jhingan* (*Lannea coromandelica*) tree amongst farmers of Khuteri village, District Mahasamund (Chhattisgarh), May 03, 2016.
- Sri N Thombare, Sc. gave field demonstrations on Gum inducer technique for tapping of saja (*Terminalia tomentosa*) tree amongst farmers of Waraseoni village, Balaghat (Madhya Pradesh), May 04, 2016.
- Dr. A Mohanasundaram, Sc. delivered lecture on Lac insect: An overview to faculty, students and research scholars of PJTSAU, Hyderabad and KFRI, Hyderabad, May 11 & 13, 2016, respectively.
- Dr. A Mohanasundaram, Sc. imparted on-farm-training on Lac cultivation technique to farmers under Network Project on CLIGR with Cooperating Centre, KFRI, Thrissur, May 14, 2016.
- Dr. SC Sharma, Sc. gave demonstration of Small Scale Lac Processing Unit to Sri PN Bhat, Sc. – D, Central Silk Technological Research Institute, Madiyala, Bengalore during his visit to ICAR – IINRG, Ranchi, June 18, 2016.
- Dr. Anees K, Sc. conducted one month training programme for Ms Priyanka Ghosh, B. Tech (Biotechnology) student from Lovely Professional University, Punjab on Optimization of CYP86A4 expression using pET 28a(+) vector, June 20 – July 29, 2016.
- Dr. J Ghosh, Sr. Sc. and Dr. VD Lohot, Sc. imparted project training to six B.Sc. (Biotechnology) students from Department of Biotechnology, Ranchi Women's College, Ranchi, on 'Morphological and biochemical characterization of pigeon pea (*Cajanus cajan* L.) germplasm', December 22, 2015 - January 30, 2016.
- Dr. VD Lohot, Sc. conducted 03 months training on 'Influence of lac insect feeding induced stress on physiology of *Kusum* (*S. oleosa*) tree' to M.Sc. (Biotechnology) student from Department of Biotechnology, Ranchi Women's College, Ranchi, February 15 - May 15, 2016.
- Er. SK Pandey, Sc. imparted training and demonstration of aleuritic acid to Sri Hue Weigh and Sri Swarup Dutta, Anning Decco Fine Chemical Co., Ltd., Kunming, China, July 13-14, 2016.
- Er. SK Pandey, Sc. imparted training on Dewaxed bleached lac to Sri Vinay Kumar and Sri Parash Kumar Choudhary, M/s Expert Wings Chemicals, Ranchi, July 18 – 27, 2016.
- Dr. S Srivastava, Pr. Sc. delivered a lecture on Industrial aspects of quality control for NRGs to Electronics & Communication Engineering (ECE) students from BITT Polytechnic, Ranchi, ICAR-IINRG, Ranchi, July 21, 2016.

- Er. SK Pandey, Sc. imparted training on Aleuritic acid and dewaxed decolourised lac to Sri Mahesh Sharma, Korba (Chhattisgarh), July 25 - August 03, 2016.
- Dr. A Mohanasundaram, Sc. delivered lecture-cum-demonstration on Scientific lac cultivation on different lac hosts to the farmers, Deogain village, Ranchi, July 28, 2016.
- Dr. S Ghosal, Pr. Sc. delivered a motivational lecture on Scientific lac cultivation and use of inputs in a judicial manner to farmers, Deogain village, Ranchi, July 29, 2016.
- Dr. PC Sarkar, Pr. Sc. had a presentation on Application of lac resin-based coatings for extending post-harvest life of fruits and vegetables before Institute Management Committee, ICAR-IINRG, Ranchi, August 24, 2016.
- Dr. RK Yogi, Sc. (Course Director); Dr. Alok Kumar, Sr. Sc. and Dr. AK Singh, Sr. Sc. (Co-course Directors) organized Model Training Course on Natural Resins and Gums: Agribusiness Modules for Skill and Entrepreneurship Development, ICAR-IINRG, Ranchi, September 02 -09, 2016.
- Dr. PC Sarkar, Pr. Sc. delivered a lecture on Advance techniques for characterisation of natural resins and gums to trainees sponsored by DOAC, GOI, ICAR-IINRG, Ranchi, September 07, 2016.
- Dr. AK Singh, Sr. Sc. delivered a lecture on Scientific lac cultivation as resource person in Farmers' workshop organized by TRDS, Torpa, Khunti, Ranchi, September 14, 2016.
- Dr. AK Singh, Sr. Sc. organized Open Day for school children on Eve of 93rd Foundation Day, ICAR-IINRG, Ranchi, September 19 & 21, 2016.
- Er. SK Pandey, Sc. imparted training on Aleuritic acid to Sri Vinod Lath, Raipur (Chhattisgarh), September 19 - October 07, 2016.
- Dr. A Mohanasundaram, Sc. delivered lecture-cum-demonstration on Cultivation of lac and industries based on lac, forward and backward linkages in marketing of shellac amongst Foresters/Forest Guards/JEM Members at Forester Training School, Mahilong, Ranchi, September 21, 2016.
- Dr. A Mohanasundaram, Sc. delivered lecture-cum-demonstration on Pest management for lac cultivation on different hosts amongst the farmers during Field Day for the promotion of improved technology under Improvement and evaluation of lac host programme, Putadag village, Ranchi, September 22, 2016.
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division delivered a lecture on Scientific lac cultivation for climate resilient agriculture for Jharkhand, CRUSS, Hazaribagh, September 26, 2016.
- Dr. MF Ansari, Sr. Sc. transferred the technologies of Heat and water resistant spiritless varnish (MSV005), Gasket shellac cement compound, Air-drying type insulating varnish, preparation of gummy mass and water soluble lac to Sri CK Padhi and his associate from Balaghat (Madhya Pradesh), September 26-29, 2016.
- Dr. RK Yogi, Sc. delivered a lecture on Economics and marketing aspects of lac cultivation during workshop on Feedback from lac growers and further management practices, Missing Autonomous Council (MAC), September 27-28, 2016.
- Dr. MZ Siddiqui, Pr. Sc. imparted training on Lac glaze varnish to Sri Premnath Keshri, Sikandara (Bihar), October 03 – 05, 2016.
- Dr. A Mohanasundaram, Sc. delivered invited lecture on Recent trends in lac research, Department of Agricultural Entomology, Agricultural College and Research Institute, Madurai, TNAU (Tamil Nadu), October 13, 2016.
- Dr. A Mohanasundaram, Sc. and Dr. J Ghosh, Sr. Sc. organized one day training programme on Lac culture and management for farmers, numbering 40, in collaboration with Centre for Forest Based Livelihood and Extension, Agartala at Kanchanpur village, North Tripura, October 24, 2016.
- Dr. A Mohanasundaram, Sc. delivered invited lecture on Cultivation of lac and industries based on lac amongst the farmers from Meghalaya during workshop organized by CFLE, Agartala on Broom grass and Agro-forestry at Jampui Hills, North Tripura, October 25, 2016.
- Er. SK Pandey, Sc. delivered a lecture on Lac processing: An option for rural entrepreneurship & lac processing based on rural entrepreneurship to MBA (Rural Management) students of XISS, Ranchi, TOT Division, ICAR-IINRG, Ranchi, November 08 & 11 2016.

- Dr. SC Sharma, Sc. demonstrated lac scraper for scraping operation of sticklac from lac stick to Sri Subodh Prasad, Ranchi at their site, November 16, 2016.
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division (Convener); Dr. AK Singh, Sr. Sc. and Dr. SKS Yadav, Sc. (Co-conveners) organized two refresher courses on Scientific lac cultivation, processing and uses, ICAR-IINRG, Ranchi, November 16 - 18 and December 05 - 07, 2016.
- Dr. AK Singh, Sr. Sc. delivered a lecture on Lac cultivation and best practices in 3-Day Institutional training programme for the Boards of Directors and Chief Executive Officer of Farmers Producer Organization organized by JASCOLAMPF, Ranchi, November 23, 2016.
- Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc. supervised Mr. Hemant Kumar and Mr. Ramjeewan Mahto of Ramakrishna Mission Vivekananda University, Ranchi as Supervisor and Co-supervisor, respectively, for their project work in partial fulfilment of the requirement for the degree of B.Sc. (ARTD) during 2016-17.
- Dr. AK Singh, Sr. Sc.; Dr. SKS Yadav, Sc. and Dr. RK Yogi, Sc. delivered 39 lectures in one week Farmers' training programme, 39 lectures in Trainers' training programme, 18 lectures in Summer/Winter Student Workshops, 6 lectures in Model Training Course and 6 lectures in Refresher Course during 2016-17.
- Following lectures were delivered to the students of M.Sc. (Forestry) from Guru Ghasidas Central University, Bilaspur (Chhattisgarh) under the Industrial Training on Natural Resins & Gums, organized by TOT Division, ICAR-IINRG, Ranchi, February 16-29, 2016:
  - Dr. A Mohanasundaram, Sc. delivered lectutre-cum-demonstration on Lac associated insect fauna & pest management in lac and impact of climate change on lac production, February 16, 2016.
  - Dr. Vaibhav D Lohot, Sc. delivered a lecture on Collection and conservation of lac insect and host plant biodiversity, February 19, 2016.
  - Er. SK Pandey, Sc. delivered a lecture on Lac-based technologies for entrepreneurship, February 20, 2016.
  - Dr. SC Sharma, Sc. delivered a lecture on Harvesting and tapping techniques for gums and resins, February 22, 2016.
  - Dr. MF Ansari, Sr. Sc. delivered a lecture on Industrial applications of lac and demonstrations on surface coating applications of lac, February 22 & 26, 2016.
  - Dr. S Srivastava, Pr. Sc. delivered a lecture on Quality control of NRG---Industrial perspective, February 24, 2016.
  - Dr. MZ Siddiqui, Pr. Sc. delivered a lecture on Medicinal importance of oleo-resins, February 24, 2016.
  - Dr. Thamilarasi K, Sc. delivered a lecture on Role of Biotechnology in lac production, February 24, 2016.
  - Dr. AR Chowdhury, Sc. delivered lecture-cum-demonstration on Sophisticated instruments in characterization of NRGs, February 26, 2016.
- Following lectures were delivered during 4th Winter Students Workshop on Natural Resins and Gums for B.Sc. (Forestry) 3rd year students from Guru Ghasidas Central University, Bilaspur (Chhattisgarh), organized by TOT Division, ICAR-IINRG, Ranchi, March 07 - 16, 2016:
  - Dr. A Mohanasundaram, Sc. delivered a lecture on Lac associated insect fauna and pest management in lac, March 08, 2016.
  - Dr. MF Ansari, Sr. Sc. delivered a lecture on Diversified uses of lac, March 11, 2016.
  - Dr. Thamilarasi K, Sc. delivered a lecture on Role of Biotechnology in lac production, March 11, 2016.
  - Dr. SC Sharma, Sc. delivered a lecture on Tapping techniques & tools for resins and gums, March 11, 2016.
  - Dr. S Srivastava, Pr. Sc. delivered a lecture on Quality control of NRG---Industrial perspective, March 14, 2016.
  - Er. SK Pandey, Sc. delivered a lecture on Lac-based technologies for entrepreneurship, March 14, 2016.
- Following lectures were delivered to the students of B.Sc. (Ag.) from BHU, Varanasi (Uttar

Pradesh) under 8th Summer Students Workshop on Natural Resins & Gums, organized by TOT Division, ICAR-IINRG, Ranchi, May 30 – June 08, 2016 :

- Dr. N Prasad, Pr. Sc. & Head, PPD Division delivered a lecture on National scenario of production of natural resins and gums, May 31, 2016.
- Dr. S Ghosal, Pr. Sc. delivered a lecture on Raising and management of lac host trees, May 31, 2016.
- Er. SK Pandey, Sc. delivered a lecture on Lac-based technologies for entrepreneurship, June 01, 2016.
- Dr. Vaibhav D Lohot, Sc. delivered a lecture on Collection and conservation of lac insect and host plant biodiversity, June 01, 2016.
- Dr. MF Ansari, Sr. Sc. delivered a lecture on Diversified uses of lac, June 02, 2016.
- Dr. Thamilarasi K, Sc. delivered a lecture on Role of Biotechnology in lac production, June 02, 2016.
- Dr. S Srivastava, Pr. Sc. delivered a lecture on Industrial aspects of quality control for natural resins and gums, June 06, 2016.
- Dr. MZ Siddiqui, Pr. Sc. delivered a lecture on Medicinal importance of oleo-resins, June 06, 2016.
- Dr. SS Bhat, Sc. delivered a lecture on Lac Integrated Farming System, June 06, 2016.

❋ Following lectures were delivered to the students of B.Sc. (Ag.) and B.Sc. (Forestry) from BHU, Varanasi (Uttar Pradesh) and SHIATS, Allahabad (Uttar Pradesh) under 9th Summer Students Workshop on Natural Resins & Gums organized by TOT Division, ICAR-IINRG, Ranchi, June 13-22, 2016 :

- Dr. N Prasad, Pr. Sc. & Head, PPD Division delivered a lecture on National scenario of production of natural resins and gums, June 14, 2016.
- Er. SK Pandey, Sc. delivered a lecture on Lac-based technologies for entrepreneurship, June 15, 2016.
- Dr. SC Sharma, Sc. delivered a lecture on Tapping techniques & tools for resins and gums, June 15, 2016.
- Dr. A Mohanasundaram, Sc. delivered a lecture on Collection and conservation of lac insect and host biodiversity, June 15, 2016.
- Dr. MF Ansari, Sr. Sc. delivered a lecture on Diversified uses of lac, June 16, 2016.
- Dr. MZ Siddiqui, Pr. Sc. delivered a lecture on Medicinal importance of oleo-resins, June 17, 2016.
- Dr. Thamilarasi K, Sc. delivered a lecture on Role of Biotechnology in lac production, June 19, 2016.
- Dr. S Srivastava, Pr. Sc. delivered a lecture on Quality control of NRG---Industrial perspective, June 20, 2016.
- Dr. SS Bhat, Sc. delivered a lecture on Lac Integrated Farming System, June 20, 2016.

❋ Following lectures were delivered during Model Training Course on Natural Resins and Gums: Agribusiness Modules for Skill & Entrepreneurs Development, sponsored by Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture, GOI, organized by TOT Division, ICAR-IINRG, Ranchi, September 02-09, 2016:

- Dr. Anees K, Sc. delivered a lecture on Production of compounds of economic importance from resins and gums: A lac resin perspective, September 03, 2016.
- Dr. A Mohanasundaram, Sc. delivered a lecture on Demonstration of pruning, bundling, inoculation and harvesting of *rangeeni* crop on *palas* & *ber* and scrapping of lac, September 03, 2016.
- Dr. SS Bhat, Sc. delivered a lecture on Lac Integrated Farming System and business opportunities, September 05, 2016.
- Sri N Thombare, Sc. delivered a lecture-cum-visit on Recent advancement in applications of natural gums in agriculture and other industries, September 06, 2016.
- Dr. MZ Siddiqui, Pr. Sc. delivered a lecture on Medicinal importance of oleo-resins, September 08, 2016.
- Dr. MF Ansari, Sc. delivered a lecture on Surface coating applications and jute based

bio-composite industry: Opportunities for entrepreneurship development, September 08, 2016.

- Dr. AR Chowdhury, Sc. delivered a lecture on Research on processing and product development of natural resins and gums, September 08, 2016.
- Dr. S Srivastava, Pr. Sc. delivered a lecture on An industrial aspect of quality control for NRG and basic needs (skill & inputs) for establishments of testing labs, September 09, 2016.
- Er. SK Pandey, Sc. delivered a lecture on Lac processing - Seedlac, shellac, lac dye, bleached lac: Skill and entrepreneurship development oriented options, September 09, 2016.
- Dr. Vaibhav D Lohot, Sc. delivered a lecture on Collection and conservation of lac insect and host plant biodiversity, September 09, 2016.

❋ Following lectures were delivered during 5th Winter School Workshop on NRG for M.Sc. (Rural Technology & Development), ACU, Allahabad and Biotechnology students from St. Xavier's College, Ranchi, organized by TOT Division, ICAR-IINRG, Ranchi, October 18-27, 2016:

- Dr. Vaibhav D Lohot, Sc. delivered a lecture on Collection and conservation of lac insect and host plant biodiversity, October 20, 2016.
- Dr. MZ Siddiqui, Pr. Sc. delivered a lecture on Medicinal importance of oleo-resins, October 21, 2016.
- Dr. MF Ansari, Sr. Sc. delivered lecture on Diversified uses of lac, October 21, 2016.
- Dr. Thamilarasi K, Sc. delivered a lecture on Role of Biotechnology in lac production, October 21, 2016.
- Dr. S Srivastava, Pr. Sc. delivered a lecture on Quality control of NRG---Industrial perspective, October 25, 2016.
- Dr. SS Bhat, Sc. delivered a lecture on Lac Integrated Farming System, October 25, 2016.

Events – 2016

HRD Programme on Recent Advances on Lac Production, Processing Technologies and Supply Chain Management System of NRGs

ICAR-Indian Institute of Natural Resins and Gums (ICAR-IINRG) organized HRD Programme on Recent Advances on Lac Production, Processing Technologies and Supply Chain Management System of NRGs during January 12-13, 2016. Dr. AK Jaiswal, Head & Convener, chaired the inaugural and valedictory sessions. He emphasized that there is good potential of lac cultivation on *ber* (*Ziziphus mauritiana*) and urged for further dissemination of the technical know–how. Dr. AK Singh, Sr. Sc. made presentation on Lac cultivation techniques and Dr. SKS Yadav, Sc. on Chemistry of lac gum resins. Dr. RK Yogi, Sc. & Co-convener presented Current scenario of NRGs and briefed about the policy implications. Representative also shared their feedback and told that they have been benefitted during various technical sessions for production, marketing and value addition through field and industrial visits during the workshop. A total of 36 participants attended the function. Dr. AK Singh, Sr. Sc. proposed vote of thanks.

3rd Coordination Committee Meeting of Network Project on Conservation of Lac Insect Genetic Resource

3rd Co-ordination Committee Meeting of Network Project on Conservation of Lac Insect Genetic Resources (NP-CLIGR) was held during January 28-29, 2016 at State Forest Research Institute (SFRI), Jabalpur (Madhya Pradesh). The meeting was inaugurated by Dr. U Prakasham, Director, Tropical Forest Research Institute (TFRI), Jabalpur. The inaugural session was graced by the presence of Dr. PK Shukla PCCF (Rtd.); Dr. G Krishnamurthy, Director, SFRI, Jabalpur; Sri SN Nachne, Additional Director, SFRI and Dr. KK Sharma, Project Coordinator. PIs and Co-PIs from Co-operating centers were present during the meeting. Dr. U Prakasham, Director, TFRI emphasized the livelihood support role of lac cultivation in the rural population of the country. He also highlighted lac cultivation as one of the most important aspects of biodiversity conservation and enrichment. He stressed on the need of evolving new strategies for conservation of lac insect genetic resources. Dr. KK Sharma, Project Coordinator, briefed about the importance of the lac insect conservation in the country and the projects' purpose in this context. The objectives and aims with special reference to local field gene banks establishment for lac inset were emphasized. The future prospect of the project was also narrated by him. He also offered technical guidance from the lead centre for smooth functioning of the project to all the centres. Dr. Md Monobrullah, Pr. Sc. & PI briefed about the need for timely submission of duly signed Utilization Certificate and Statement of Expenditure. He concluded the session with vote of thanks to all the participants.

On 29th January 2016, all the delegates visited the lac insect field gene bank maintained at SFRI, Jabalpur. Project Coordinator advised the PI regarding the proper way of maintaining the lac insect and right methodology for taking observations. Lac growing farmers' fields were visited at Bhedaghat under the guidance of Dr. Pratibha Bhatnagar, PI and Dr. Moni Thomas, Senior Scientist, JNKVV, Jabalpur. Post lunch, the delegates discussed the overall activities and future course of action of the project. The PC thanked all the partners for their good performance and expressed the hope of doing better in future.

3rd Co-ordination Committee Meeting of Network Project on Conservation of Lac Insect Genetic Resources

Visit to the Regional Lac Insect Field Gene Bank by delegates of the 3rd Co-ordination Committee Meeting

Research - Extension - Farmer's Interface - cum - Workshop on Lac Cultivation organized at Torpa, Khunti, Ranchi

On the occasion of 5th Technology Fortnight a Research - Extension - Farmer's Interface - cum - Workshop on Lac Cultivation was organized by ICAR-IINRG on February 05, 2016 at Torpa, Khunti, Ranchi (Jharkhand) under the collaborative project of Government of Jharkhand. The function was inaugurated by the Chief Guest, Shri Vinaya Kumar, District Planning Officer and Director, Torpa Rural Development Society for Women (TRDS), Khunti and presided over by Dr. KK Sharma, Director, ICAR-IINRG, Ranchi. Officials from different departments local representatives and media persons were also present on this occasion. Director, TRDS welcomed all the dignitaries. Sri Vinaya Kumar in his address appreciated the initiatives of ICAR-IINRG, Ranchi. He congratulated the progressive farmers and members of Self Help Groups (SHGs) benefitted under this project. Further, he also encouraged farmers for primary processing of sticklac for better price. He emphasized that they should learn and adopt the scientific methods of lac cultivation through capacity building and skill development programmes conducted by the ICAR-IINRG, Ranchi.

Dr. KK Sharma emphasized that lac cultivation is the best option for additional income for the villagers. He appreciated the joint efforts of District Planning Office, Khunti, Government of Jharkhand and TRDS, Torpa, Khunti. He also visited the site of the Small Scale Lac Processing Unit (SSLPU) and explained the benefits of this technology. He said that the Institute would continue to provide technical support through training, field visits, monitoring and technical guidance to the stakeholders. He also briefed about the activities of newly established KVK in Khunti District and requested for the support from the district administration. He informed that two SSLPU have already been established in Arki and Torpa blocks of Khunti district. Both units are functional and primary level processing has been started.

During technical sessions, Dr. AK Singh, Sr. Sc. and Dr. RK Yogi, Sc., ICAR-IINRG, Ranchi delivered the lectures on lac cultivation and marketing issues. A total of 70 participants including farmers, members of SHGs, local representatives, scientists and officials participated in the programme.

Director, ICAR-IINRG addressing the participants

Annual Lac *Kisan Mela*-cum-Exhibition organized in the Institute

The Annual *Kisan Mela*-cum-Exhibition was organised on February 10, 2016. The *Mela* was inaugurated by Shri Randhir Kumar Singh, Hon'ble Agriculture Minister, Government of Jharkhand. Sri Ram Tahal Choudhary, Hon'ble Member of Parliament, Ranchi, Jharkhand and Dr. George John, Vice-Chancellor, BAU, Ranchi as a Guest of Honour were also present on the occasion. More than 800 farmers and other stakeholders participated in the *mela*. Scientists and the officials from sister organizations ICAR-IIAB, ICAR-RCER RC, ICAR-IARI-J were also present during inaugural function.

Hon'ble Agriculture Minister spoke about the government strategies to strengthen the farming community. Government efforts are directed to benefit the lac growers, he said and promised to discuss issues related to lac sector with the Chief Minister of Jharkhand. He asserted that lac production is more important in terms of livelihood security for the lac growers and applauded the efforts done by the Institute to generate awareness amongst the farmers for undertaking scientific lac cultivation. Sri Singh appreciated the contributions of the Institute and stressed that the State Government will render all support to the Institute in its endeavour. He also honoured progressive lac farmers for their achievements in lac production.

Sri Ram Tahal Choudhary opined that small scale industry may be more useful to boost the rural economy and all the rural community should participate actively in *Yojna Banao Abhiyan* (*Gram Panchyat* Development Planning) for need based infrastructure development.

Dr. John in his address emphasized on special research on alternate lac host plants as a need of hour. He opined that market support both forward

and backward, is an essential activity to encourage the lac growers. Primary level processing units may be helpful to get better prices.

Dr. KK Sharma, Director, ICAR-IINRG, Ranchi in his welcome address threw light on research achievements, activities and various programmes of the Institute for the welfare of lac farmers. He announced that this institute has been granted ISO-9001-2008 Certification and also informed to the Chief Guest about three major issues related to procurement of sticklac at minimum support price, consideration of lac as an agricultural produce and establishment of lac specific commodity board to promote the lac at domestic as well as overseas area.

The farmers also visited Institute Research Farm and Museum. They were apprised of the various lac production technologies, new lac-host plants introduced for lac cultivation and pest management techniques. A *Kisan Ghosti* was organized in the afternoon session wherein experts from BAU, ICAR-RCER RC, Institute of Forest Productivity (IFP), Central Silk Research Board and ICAR-IINRG interacted with the farmers and provided solutions to the problems faced by them in lac cultivation and other agricultural crops.

Earlier, an exhibition comprising of 24 stalls from different organizations was inaugurated by the Hon'ble Minister. Awards were given to farmers/lac production entrepreneurs/executives for production and promotion of lac.

Inauguration of *Kisan Mela*-2016 by the Hon'ble Minister

Participants in *Kisan Mela*-cum-Exhibition-2016

Industrial Training on Natural Resins an Gums

Industrial Training on Natural Resins and Gums was organized by TOT Division, ICAR-IINRG during February 16-29, 2016 for M.Sc. (Forestry) students from Guru Ghasidas Central University, Bilaspur (Chhattisgarh). The workshop was inaugurated by the Dr. KK Sharma, Director, on 15th February, 2016. Training was imparted on processing of natural resins like lac, rosin, oleo-reins and their industrial applications. Students were also educated about seed gums and exudates gums: harvesting, tapping, collection, processing, quality control and their industrial uses. Students were also exposed to horticulture, tasar culture, forestry and allied activities.

National Science Day

ICAR-IINRG celebrated National Science Day on February 29, 2016 to commemorate the discovery of Raman Effect by Dr. CV Raman. The National Science Day was observed on the theme 'Make in India: Science and Technology driven Innovation. Dr. Mohan Verma, Professor and Head, Department of Space Engineering and Rocketry, Birla Institute of Technology, Mesra, Ranchi delivered an enlightening lecture on the above theme. He emphasized on scientific tradition of ancient India and reminded us of the need for motivating leadership in scientific community for advancement of science and technology in India. Dr. KK Sharma, Director, ICAR-IINRG, Ranchi delivered the welcome address. Dr. MF Ansari, Sr. Sc. & Convener introduced the significance of the National Science Day.

Dr. KK Sharma presenting the memento to Dr. Varma

4th Winter Students Workshop on Natural Resins and Gums

4th Winter Students Workshop on Natural Resins and Gums was organized by TOT Division, ICAR-IINRG during March 07-16, 2016 for B.Sc. (Forestry) students numbering 33 from Guru Ghasidas Central University, Bilaspur (Chhattisgarh).

International Women's Day

International Women's Day was celebrated in the Institute on March 09, 2016 with the theme, 'Make it happen'. Smt. Sampat Meena, IG (Organized Crime), CID, Jharkhand was the Guest Speaker on the occasion. Speaking on the occasion she narrated that the human trafficking is a big issue of Jharkhand and briefed about 'Operation Muskan' conducted by her. In his welcome address, Dr. KK Sharma, Director, ICAR-IINRG briefed about the various on-going activities including research and trainings given to the lac-growers, farmers and other interested persons in the Institute. He also informed that there is a functional 'Women Cell' in the Institute to take care of the women related issues. Dr. MZ Siddiqui, Pr. Sc. & Convener of the programme stressed upon the need and importance of the Women's Day celebration in the Institute. Dr. Thamilarasi K, Sc. proposed vote of thanks.

The Chief Guest addressing the gathering

Swachchh Bharat Abhiyan-cum- *Kisan Gosthi*

Swachchh Bharat Abhiyan-cum-Kisan Gosthi was organized at Sarjamdih village Block-Angara, District-Ranchi (under 'MGMG' adopted village) on May 30, 2016. On this occasion, a team consisting of Dr. KK Sharma, Director, Dr. Alok Kumar, Sr. Sc., Dr. SC Sharma, Sc., Sri DK Singh, STO, ICAR-IINRG Ranchi along with Dr. Rajesh Kumar, SMS, KVK, Ranchi interacted with the farmers. The representatives of Sarjamdih Panchayat welcome the officials of ICAR-IINRG & KVK Ranchi and highlighted the importance of the event. Villagers of the Sarjamdih panchayat raised the problems faced during lac cultivation practices and also requested to provide the lac host saplings from the Institute for planting in rainy season. In presidential speech, Dr. KK Sharma, Director focused on the importance of *Swachh Bharat Abhiyan* in our day to day life and suggested to farmers to adopt the scientific lac cultivation. He also accepted the request of villagers and announced to provide more than 300 lac host plants to potential farmers at the earliest possible.

Welcome of the experts by the villagers

Participants of the *Swachchh Bharat Abhiyan*-cum-*Kisan Gosthi*

8th Summer Students Workshop on NRGs

8th Summer Students Workshop on Natural Resins and Gums was organized by ICAR-IINRG, Ranchi during May 30 to June 08, 2016. The workshop was inaugurated by Dr. KK Sharma, Director, ICAR-IINRG, Ranchi. In his Inaugural speech, he told that special attention is being given to the eastern states because of their rich biodiversity and to usher in the second green revolution in the country. He said that this biodiversity has to be exploited to augment the production of natural resins and gums and stressed that there is need to integrate agriculture with forestry for increasing income and land use diversification. Lac cultivation prevents deforestation due to sustainable income from the lac host trees and this ultimately helps in culminating the climate change.

The workshop was organized for 40 students of Agriculture from Banaras Hindu University (BHU), Varanasi and Acharya NG Ranga Agriculture University, Hyderabad. The theme of the workshop was Lac production, tapping, processing and applications of natural resins and gums. Students were educated about processing of natural resins like lac, rosin, oleo-resins, exudate as well as seed gums and their industrial applications. Harvesting / tapping, collection, quality control, value addition and industrial uses were also covered. Visit to a lac industry to expose the students to various processes in refinement of lac, its value addition and extraction of lac dye and exposure-cum-educational visit to ICAR-RCER and IFP, Ranchi was organized to acquaint them with horticulture and forest management, biodiversity conservation and ecological security. The valedictory function was organized on 8th June, 2016. Dr. KK Sharma, Director interacted with the students to get their feedback for improvement in the programme in future. He was hopeful that students will play a vital role in creating awareness about natural resins and gums. On this occasion Heads of Divisions also expressed their views. The workshop was coordinated by Dr. SKS Yadav, Sc., TOT Division.

Trainees of 8th Summer Workshop with experts

Expert demonstrating the quality testing methodologies

9th Summer Students Workshop on Natural Resins and Gums organized at ICAR-IINRG, Ranchi

9th Summer Students Workshop on Natural Resins and Gums was organized by ICAR-IINRG during June 13-22, 2016. The workshop commenced with the interaction of the students and experts on 13th June, 2015. Fifty one students, 16 B.Sc.(Ag.) student from BHU, Varanasi and 35 B.Sc. (Forestry) student from Sam Higginbottom Institute of Agriculture, Technology and Sciences (SHIATS), Allahabad participated in the workshop. These students were from the states of Bihar (14), Jharkhand (14), Chhattisgarh (2), Madhya Pradesh (5), Uttar Pradesh (4), Odisha (1) and north eastern states of Nagaland (9) and Meghalaya (2).

The theme of the workshop was Educational training on lac production, tapping, processing and applications of natural resins and gums to the students. Students were educated about processing of natural resins like lac, rosin, oleo-resins and their industrial applications. Training was also imparted about exudate as well as seed gums. Topics on harvesting/tapping, collection, processing, quality control and their value addition and industrial uses were also covered. An industrial visit to expose the students about various processes in refinement of lac, its value addition and extraction of lac dye was also conducted to a lac processing industry in Khunti. Exposure-cum-educational visit to ICAR-RCER and IFP, Ranchi was also organized to acquaint them with horticulture and forest management, biodiversity conservation and ecological security.

The valedictory function was organized on 22nd June, 2016. Dr. KK Sharma, Director of the Institute interacted with the students to get their feedback for improvement in the programme in future. He stressed that lac cultivation helps in forest conservation due to inherent lac-culture operations and thereby helps in preventing climate change. He was hopeful that students will play a vital role in creating more awareness in public about natural resins and gums. Dr. AK Jaiswal, Head, TOT Division informed that Institute is strengthening the extension activities in southern part of the country like Karnataka and also in North Eastern states through NEH Plan. Dr. N Prasad, Head, PPD Division, explained the activities of the Institute on processing and value addition of natural resins and

gums. Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, West Bengal and eastern Uttar Pradesh are the seven States where the government has embarked on the journey to bring the second Green Revolution through sustainable farm practices using water management and conservation. Dr. AK Singh, Sr. Sc. also expressed his views and wished trainees all success in their future endeavors. A cultural programme was also organized in the evening on 21st June, 2016 in which student trainees performed dance, comedy, singing and drama etc. Workshop was coordinated by Dr. SKS Yadav, Sc., TOT Division.

Trainees of 9th Summer Workshop on Natural Resins and Gums

2nd International Yoga Day

2nd International Yoga Day was jointly organized by ICAR-IINRG and ICAR-Indian Institute of Agricultural Biotechnology, Ranchi on June 21, 2016, at ICAR-IINRG, Ranchi. Dr. KK Sharma, Director, ICAR-IINRG welcomed the Yoga Instructors, all the staff and emphasized on the importance of practicing yoga daily. About 70 scientists, staff members including contractual staffs of ICAR-IINRG & ICAR-IIAB, Ranchi participated and practiced Yoga under guidance of the invited Yoga Instructors. A lecture on '*Yogasan: Manav swasthya ka sakaratamak pahlu*' was also delivered on this occasion by the Yoga Instructor along with demonstration of Yoga practices as per the Common Yoga Protocol (CYP) issued by Ministry of Ayush, Government of India.

Staff performing Yoga under the instructions of Yoga Expert

ICAR-IINRG trains Chinese Firm on Technical Know-How of Aleuritic Acid Technology

A two days training-cum-demonstration on 'Technical know-how of aleuritic acid technology' was conducted for the two representatives of Anning Decco Fine Chemical Co., Ltd., Kunming, China during July 13-14, 2016. The firm is a joint venture between Decco, a world leader in post harvest and the state owned Yunnan Anning Chemicals located at Kunming, Anning in the South West of China. The US FDA registered and Kosher certified firm is the largest producer of shellac in China and the second largest in the world, exporting to many countries. During the training, preparation of aleuritic acid (both technical and pure) was successfully demonstrated to them at pilot plant scale. In the process, they were also acquainted with maintaining different process parameters to get the desired yield and purity of aleuritic acid which was their major concern. Queries raised by them on different aspects of aleuritic acid preparation were discussed and replied to their satisfaction. The Agrinnovate India, an ICAR company played a major role in processing the training proposal and arranging the logistics support for them. Revenue in terms of programme fee of USD 1328.25 (including training fee of USD 1000 to ICAR-IINRG) was generated. Trainees were given certificates on successful completion of the training.

Pre training discussion & demonstration of the process

Institute organized Field Day

At Deogain village, Ranchi

A field day followed by practical field demonstrations was organised for the promotion of Lac Integrated Farming system amongst the farmers of village Deogain, Ranchi on July 28, 2016. Dr. SS Bhat, Sc. (Agroforestry) & Convener of the programme, welcomed the farmers and the guests and briefed about the essence of the programme towards promotion and adoption of lac based integrated

farming. He thoroughly explained how integrated farming is an efficient sustainable resource management for maximum productivity from the cropping system, with multiple components like trees, crops and livestock arranged spatially and temporarily over the same unit of land for the best utilization of the growing space and also that how integrated farming acts as insurance against total crop failure and acts as a potent tool to combat the vulnerability from climate change. He stressed upon the adoption of *semialata* based integrated cropping system with mixed cropping, crop rotation and inter-cropping for the least competition for water, nutrition and space and adopting sustainable eco-friendly practices. Dr. S Ghosal, Pr. Sc. (Agronomy), highlighted some success stories of lac cultivation and briefed about the agronomic practices of lac cultivation. He explained the benefits of fertilizer application for increasing lac productivity and demonstrated the application of recommended doses of fertilizer on selected trees of *ber* trees. Dr. A Mohanasundaram, Sc. (Agril Entomology) highlighted the packages and practices of lac cultivation and emphasized the farmers to adopt the practice of scientific lac cultivation.

Dr. KK Sharma, Director exhorted the farmers to adopt lac integrated farming system for sustainable livelihood. He interacted with the farmers and cleared some misconceptions of the farmers regarding lac cultivation. He distributed vegetable seeds amongst the innovative farmers for use in the adopted system. They were also provided literature on lac integrated farming system and lac cultivation on different hosts.

Scientist-farmer interaction and seed distribution at Deogain, Ranchi

At Putadag village, Ranchi

Dr. J Ghosh, Sr. Sc. organized a field day to educate the farmers over new technology developed by the Institute at Putadag village of Angara, Ranchi on September 22, 2016. Technology on advantages of lac cultivation on fruit *ber* varieties over existing wild *ber* varieties, *kusmi* lac cultivation on *swadi palas* and protection of lac crop from various enemy insects and role of lac insect/host plant biodiversity conservation were briefed.

Field Day at Putadag, Ranchi

Model Training Course on Natural Resins and Gums: Agribusiness Modules for Skill and Entrepreneurship Development

A Model Training Course on Natural Resins and Gums: Agribusiness Modules for Skill and Entrepreneurship Development, sponsored by Directorate of Extension, Ministry of Agriculture & Farmers Welfare, GOI, New Delhi, was organized by ICAR-IINRG during September 02 –09, 2016. Dr. H Sinha, Professor (Rural Management) & Head, Department of Research and Planning, Xavier Institute of Social Service, Ranchi, inaugurated the programme as Chief Guest on September 02, 2016. Dr. N Prasad, Director (Actg.) and Dr. AK Jaiswal, Head, TOT Division, ICAR-IINRG, Ranchi welcomed Chief Guest and 23 participants from various Institutes, Officials from State Forest Departments, Cooperative Federations and Agricultural Departments from Jharkhand (11), Chhattisgarh (3), Assam (2), Tamil Nadu (1), Madhya Pradesh (1), Arunachal Pradesh (1), Nagaland (1), Mizoram (1), Delhi (1) and Bihar (1). Dr. Sinha in his address emphasized overall aspects of NRG sector

including production, processing, value addition and product development need to be addressed simultaneously for sustainable development. He also briefed about the need for market promotion of NRG based product through variation in application and design of the products. Regular supply of raw material is the key factor for processing industry. Keeping in view of global competition, he also informed that recently designed minimum support price mechanism for minor forest produce including lac and *karaya* gum may play important role in safeguarding the households in tribal areas against the price fluctuation. He appreciated the efforts of the Institute in the field of NRG sector and complimented for organizing such events, especially training programme on Agribusiness Modules for Skill & Entrepreneurs Development which is the need of the hour. In his speech, he advised that lac production along with other NRGs might be a good option for the development of entrepreneurship. Dr. N Prasad in his Presidential address briefed about the achievements of the Institute and further scope of NRG sector for livelihood security and earning foreign exchange. Dr. AK Singh, Head, LP Division briefed about the strategies for productivity and quality enhancements of lac produce in India. Dignitaries including Head of the Divisions and scientists participated in the inaugural programme. Dr. AK Singh, Sr. Sc. & Co-course Director proposed vote of thanks.

Lightening of lamp by the Chief Guest

Address by the Chief Guest during Inaugural function

Hon'ble Governor of Jharkhand visited ICAR-IINRG, Ranchi

Hon'ble Governor of Jharkhand, Smt. Droupadi Murmu, visited ICAR-IINRG, Ranchi on September 09, 2016. During the visit, Hon'ble Governor planted a sapling of *kusum* (*Schleichera oleosa*) at Institute Research Farm, ICAR-IINRG Ranchi and also visited the Institute museum. During visit at Surface Coating Laboratory, various lac based coating technologies were demonstrated. She also chaired the valedictory function of the Model Training Course during 02nd–09th September, 2016 sponsored by Directorate of Extension, Ministry of Agriculture & Farmers Welfare, GOI, New Delhi. On this occasion a training manual on Natural Resins and Gums: Agribusiness Modules for Skill and Entrepreneurship Development was released by the Hon'ble Governor. Participants numbering 23 from various Institutes, Officials from State Forest Departments, Cooperative Federations and Agricultural Departments from Jharkhand, Chhattisgarh, Assam, Tamil Nadu, Madhya Pradesh, Arunachal Pradesh, Nagaland, Mizoram and Delhi received the certificates from the Hon'ble Governor.

In her address, Smt. Droupadi Murmu appreciated the efforts of the scientists and congratulated to the participants for successful completion of the training programme. She also emphasized to strengthen marketing facilities for natural resins and gums including lac.

In his welcome address, Dr. KK Sharma, Director briefed about the various research and extension activities of the Institute. Dr. Alok Kumar, Sr. Sc. and Co-course Director, proposed vote of thanks.

Planting of *Kusum* sapling at IRF by Hon'ble Governor, Jharkhand

Hon'ble Governor addressing the participants of the Model Training Course

93rd Foundation Day Celebration

ICAR-IINRG celebrated its 93rd Foundation Day on September 20, 2016. While welcoming the guest and audience, Dr. KK Sharma, Director of the Institute dwelt upon the recent achievement of the Institute. Shri Saryu Rai, Minister for Food, Public Distribution, Consumer Affairs and Parliamentary Affairs, Govt. of Jharkhand graced the occasion as Chief Guest. He opined that the use of components of biological diversity must be in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspiration of present and future generation. Guest of Honour Dr. Kailash Chandra, Director, Zoological Survey of India, Kolkata delivered 6th Ms Dorothy Norris Memorial Lecture in the honour of Founder Director of the erstwhile Indian Lac Research Institute on this occasion. He emphasized upon the importance of biological diversity and necessity to conserve it. He told that the ecosystem services provided by the biological components are at present under-exploited and the time has arrived to realize the importance of the same. Dignitaries and scientists from CTRTI, ICAR-IIAB, ICAR-RCER, Regional Station of NBPGR and other officials from different organizations participated in the programme. Monograph on *Palas* and a technical bulletin on Model Bankable Projects on Lac Cultivation for Livelihood Security were released on this occasion by the Chief Guest. Distinguished workers of the Institute in various categories were felicitated during the function. Dr. Alok Kumar and Dr. Thamilarasi K (Category: Scientist), Dr. Anjesh Kumar and Shri Binod Kumar (Category: Technical), Shri Anant Pandey (Category: Admin.), Shri Suresh Pandit and Shri Jaleswar Horo (Category: SSS) were awarded with certificates and mementos for their outstanding contributions in their sphere of work. Dr. Md Monobrullah, Convener, proposed vote of thanks. Dr. J Ghosh and Dr. A Mohanasundaram were Co- conveners of the Foundation Day programme. A cultural event was organized in the evening where in employees of the local ICAR Institutes along with their family members enjoyed *Hasya Kavi Sammelan*. Institute also observed open days on 19th and 21st September, 2016 for the students in which 1007 students from seven schools of the city visited the Institute. An exposure-cum-educational visit of Institute Research Farm was organized to show the students different lac hosts and standing crop of lac along with lac insect. They were shown around the NRG Museum and a documentary on lac was also screened for them.

Director, ICAR-IINRG welcoming the Chief Guest and the participants

Release of the Monograph on *Palas* by the dignitaries

8th Annual Workshop of Network Project on Harvesting, Processing & Value Addition (HPVA) of Natural Resins and Gums (NRG)

The 8th Annual Workshop of Network Project on Harvesting, Processing & Value Addition (HPVA) of Natural Resins and Gums (NRG) was held at KAU-College of Forestry, Vellanikkara, Thrissur (Kerala) during October 06-07, 2016. The inaugural session was presided by Dr. Mercy George, Associate Director

(Research), KAU, Thrissur and graced by the presence of Dr. Kanchan K Singh, Assistant Director General (Engg.), ICAR, New Delhi and Dr. KK Sharma, Director, ICAR-IINRG, Ranchi. The Project Coordinator, PIs, Co-PIs and RAs of different centres were present. Dr. Mercy George in her opening remarks said that Western Ghat regions are rich in trees producing natural resins and gums which have potentials to earn a lot of foreign exchange. She also told that NRGs were mainly traditionally used which should be expanded to other sectors like pharmaceutical and related industries. Dr. Kanchan K Singh emphasized upon the mechanized harvesting systems and processing technology of NRGs. He added that value addition of NRGs is an urgent need for better visibility of the products. He also stressed upon the processing protocols, biomass utilization and improved utilization of resources for increased efficiency and profitability to the farmers. Dr. KK Sharma expressed the ideas of biodiversity studies and documentation of traditional uses of NRGs. Dr. N Prasad presented the overall progress report and salient achievements of the project. The technical session of the meeting was chaired by Dr. Kanchan K Singh and Co-chaired by Dr. KK Sharma in which PIs of Network Project centres presented their progress, action taken report for the year 2015-16 and technical programme for 2016-17. On 7th October, 2016 concluding session was chaired by Dr. Kanchan K Singh, in which final recommendations were presented followed by vote of thanks by Dr. K Vidyasagaran, PI, KAU-College of Forestry, Vellanikkara, Thrissur (Kerala).

Inaugural session of the workshop

5th Winter Students Workshop on Natural Resins and Gums organized at ICAR-IINRG, Ranchi

Total 38 students attended the workshop organized at ICAR-IINRG, Ranchi during October 18-27, 2016. Sixteen M.Sc. (Rural Technology & Development) students from University of Allahabad (Uttar Pradesh) and 22 B.Sc. (Biotechnology) students from St. Xavier's College, Ranchi attended the workshop.

Student receiving the certificate from Dr. KK Sharma, Director during Valedictory Session

Trainee students of 5th Winter Students Workshop

सतर्कता जागरूकता सप्ताह

संस्थान द्वारा दिनांक 31.10.2016 से 05.11.2016 तक सतर्कता जागरूकता सप्ताह का आयोजन किया गया। इस क्रम में दिनांक 31.10.2016 को पूर्वाहन 11.00 बजे निदेशक कार्यालय के समक्ष संस्थान के निदेशक डॉ. केवल कृष्ण शर्मा द्वारा सभी अधिकारियों/कर्मचारियों/विभिन्न परियोजनाओं में कार्यरत संविदा कर्मियों इत्यादि को सतर्कता जागरूकता शपथ दिलायी गयी। इस साप्ताहिक आयोजन के दौरान संस्थान के सभी कर्मियों को समय-समय पर सतर्कता से संबंधित जानकारी प्रदान की गयी।

दिनांक 02.11.2016 को इस आयोजन का समापन समारोह आयोजित किया गया। इस अवसर पर श्री अमर नाथ मिश्रा, मुख्य अतिथि पुलिस अधीक्षक, ए.सी.बी., सतर्कता एवं निगरानी विभाग, राँची, झारखंड ने निष्ठा को प्रोत्साहित करने और भ्रष्टाचार को समाप्त करने में जनता की भागीदारी (Public participation in promoting integrity and eradicating corruption) विषयक व्याख्यान देते हुए कहा कि समाज के प्रत्येक क्षेत्र में जागरूकता जीवन को सुगम बनाती है, लोक

सेवकों के बीच अपने कार्य के प्रतिनिष्ठा एवं ईमानदारी सब से महत्वपूर्ण है। इससे न सिर्फ कार्य कुशलता बढ़ती है, बल्कि विकास के नए रास्ते भी खुलते हैं। उन्होंने बताया कि भ्रष्टाचार विकास के मार्ग में सब से बड़ी बाधा है तथा इस बात पर बल दिया कि सरकारी काम काज में पारदर्शिता एवं जवाब देही के द्वारा भ्रष्टाचार को कम किया जा सकता है। उन्होंने भ्रष्टाचार निवारण में प्रौद्योगिकी की भूमिका की भी सराहना की।

कार्यक्रम में स्वागत भाषण करते हुए डॉ. केवल कृष्ण शर्मा, निदेशक ने संस्थान की गतिविधियों की जानकारी दी तथा संस्थान के कार्यो के परिप्रेक्ष्य में सतर्कता जागरूकता की उपयोगिता परचर्चा की। समापन समारोह के अवसर पर संस्थान के सतर्कता अधिकारी एवं प्रधान वैज्ञानिक डॉ. सोमेन घोषाल ने भी अपने विचार प्रस्तुत किये। कार्यक्रम का संचालन डॉ. अंजेश कुमार, वरिष्ठ तकनीकी अधिकारी ने किया।

निदेशक, डॉ. केवल कृष्ण शर्मा अधिकारियों/कर्मचारियों को सतर्कता जागरूकता शपथ दिलवाते हुये

HRD Programme on Lac Cultivation, Processing and Value Chain: An Option for Entrepreneurship Development in Rural Areas

ICAR-IINRG, Ranchi organized a one day HRD Programme on Lac Cultivation, Processing and Value Chain: An Option for Entrepreneurship Development in Rural Areas on November 08, 2016. Dr. H Sinha, Professor (Rural Management) & Head, Department of Research and Planning, Xavier Institute of Social Service, Ranchi, inaugurated the function as Chief Guest and briefed about the aim of the workshop for MBA (Rural management) students. Dr. KK Sharma, Director, ICAR-IINRG, in his welcome address briefed the achievements of the Institute in the field of production and value addition of lac. Further, he also briefed about the various issues of procurement and marketing of lac. He informed that Minimum Support Price (MSP) has been announced by the government of India and procurement of scraped lac has been started in PESA states under the jurisdiction of TRIFED as nodal agency. Dr. AK Jaiswal, Head & Convener chaired the Brain Storming Session on management aspects of lac cultivation, processing & marketing and briefed about the various opportunities and challenges in scientific lac cultivation in rural areas. He also informed the delegates for further dissemination of the technical know–how and emphasized that there is good potential of lac cultivation on *ber* (*Ziziphus mauritiana*).

Er. SK Pandey, Sc. delivered lecture on Lac processing: An option for rural entrepreneurship and Dr. SKS Yadav, Sc. on Value addition and application of NRGs: An option for entrepreneurship development. Dr. RK Yogi, Sc. & Co-convener presented the policy implications and report on the various technical sessions. Representative also shared their feedback and told that they have been benefitted during various technical sessions for production, marketing and value addition through field and industrial visits during the workshop. On this occasion, a total of 74 including 37 male and 37 female participants attended the programme. Dr. AK Singh, Sr. Sc. proposed vote of thanks.

1st Refresher Course on Scientific Cultivation, Processing and Uses of Lac

1st Refresher Course on updating skills with recent development on scientific cultivation, processing and uses of lac was organized by ICAR-IINRG during November 16-18, 2016. The three-day course sponsored by Jharkhand State Livelihood Promotion Society (JSLPS), Ranchi was specifically organized for 38 *Ajeevika Vanopaj Mitras* (AVMs) of three districts of Jharkhand (Simdega, W. Singhbhum and Ranchi) and it was inaugurated by Dr. KK Sharma, Director. He appreciated the initiative taken by JSLPS to refresh the knowledge of AVMs. Later, during interaction session participants shared their views on major problems and lac cultivation operations in practice with Dr. AK Jaiswal, Convener & Head, TOT Division; Dr. AK Singh, Co-convener & Sr. Sc. and other experts of the Institute.

Major gaps in the skill of AVMs identified were: (i) lack of knowledge of identification of predators and parasites of lac culture, (ii) recent recommended insecticides and fungicides, treatment of broodlac by dipping in recommended insecticides, (iii) quality of broodlac, (iv) mortality of lac insect due to sooty

mould, (v) lac cultivation on bushy host, *Flemingia semialata*, (vi) organized mixed lac host plantation, (vii) small scale lac processing unit and (viii) proper marketing of the produce, etc. Experts of the Institute explained the various queries during class room and practical sessions. AVMs also showed keen interest in the subject during various interaction sessions by updating their skills and clearing doubts.

The valedictory function of the refresher course was organized on 18th November, 2016. The Chief Guest of the function was Sri Paritosh Upadhyay (IFS), CEO, Jharkhand State Livelihood Promotion Society, Ranchi. He complimented the efforts of ICAR-IINRG for organizing such events for the benefit of farmers. Sri Upadhyay emphasized on creating self-reliance in broodlac availability and asked the AVMs to increase the number of beneficiaries so that benefits of lac cultivation reach to the maximum farmers.

Dr. KK Sharma, Director highlighted the importance of lac cultivation and advised the AVMs to motivate the farmers to practice improved methods of cultivation. Dr. AK Jaiswal desired that participants would apply their skill in field for achieving higher productivity.

Activities during 1st Refresher Course

Agricultural Education Day

Birth anniversary of first President of Independent India and Union Minister of Agriculture, Bharat Ratna, Dr. Rajendra Prasad was observed as 'Agricultural Education Day' on December 03, 2016. To commemorate the day, team of scientists and other staff visited Siyankel & Ghanghari villages of Khunti and Beradih village of Ranchi, respectively. They interacted with the farmers for enhancing their technical know-how especially on lac cultivation and educated the farmers for importance of agriculture in the development of their own and the society, motivated them to choose agriculture education for their children, build professional career in agriculture based organizations and become agri-entrepreneurs in future.

Experts interacting with farmers

World Soil Day

ICAR-IINRG, Ranchi celebrated the World Soil Day on December 05, 2016. To commemorate the day team members of 'MGMG' programme visited Sarjamdih, Mangubandh and Beradih villages. During interaction with farmers importance of the World Soil Day, demerits of over-use of chemicals and fertilizers and importance of fertilizer application for *kusmi* lac production on *ber* was explained. During the function to celebrate the Day, Dr. N Prasad, Head, PPD Division emphasized the importance of soils for sustaining forest ecosystem. He urged the people to protect the soils as it is a critical component of the natural system and a vital contributor in our lives through its contribution to food, water and energy security. Dr. AK Jaiswal, Head, TOT Division highlighted the function and role of soils. He also suggested the farmers to use the vermi-compost and organic fertilizers for better soil health.

Dr. S Ghosal, Pr. Sc. informed the farmer-trainees and participants that soil is the 'blood and soul of infinite life'. He told that it is the duty of all to protect our soils. Earlier, he made a presentation on Soil mineral nutrients – Its role in plant system and availability in soils to educate the scientists, technical staff and farmers on the different characteristics and functions of soils. An

interaction session with the farmers was also organized on the occasion and various queries of farmers related to soil health and preparation of farm yard manure and vermin-compost were answered by the experts.

World Soil Day Celebrations at Sarjamdih village and in the Institute

2nd Refresher Course on Scientific Cultivation, Processing and Uses of Lac

For updating skills with recent technological development on scientific lac cultivation, processing and uses, 2nd Refresher Course was organized at ICAR-IINRG, Ranchi during December 5-7, 2016. The course was sponsored by Jharkhand State Livelihood Promotion Society (JSLPS), Ranchi. The refresher course commenced with the interaction of the participants with experts of the Institute on 5th December, 2016. A total of 19 *Ajeevika Vanopaj Mitras* (AVMs) of W. Singhbhum district of Jharkhand participated in the course.

Technical-cum-Interaction session of participants with various experts was organized on all aspect of lac cultivation, processing and uses during three days. Participants shared their views on major problems and lac cultivation operations in practice. AVMs showed keen interest in the subject during various interaction sessions by updating their skills and clearing doubts. In the concluding session of the refresher course on 7th December, 2016, participants gave their feedback and certificates were given to all the participants.

Jai Kisan Jai Vigyan Week

ICAR-IINRG, Ranchi celebrated *Jai Kisan Jai Vigyan* week during December 23-29, 2016. As a part of celebrations, different activities like farmers' visit to Institute Research Farm and NRG Museum to demonstrate the recent lac cultivation technologies, farmers-scientist Interaction meet, screening of video documentary on scientific lac cultivation, processing and value addition, and one to one programme on lac cultivation, pest management and market intelligence were organized for more than 100 farmers of Jharkhand, Odisha and West Bengal.

A scientist-farmers interface was organized at the institute on 29th December, 2016. In his concluding remark, Dr. KK Sharma, Director, ICAR-IINRG informed about contributions of two former Prime Minister Shri Atal Bihari Vajpayee and Late Shri Chaudhary Charan Singh and stressed upon the role of farmers to make India self reliant. He also emphasized that the innovations in science and technology should reach to the farmers for increasing productivity and income. Dr. AK Jaiswal Head, TOT Division emphasized on linkage between farmers and scientists for effective transfer of technologies and briefed about the activities organized during celebration. The programme was attended by Dr. AK Mandal, Project Director, ATMA, Purulia (WB) along with his staff, more than 55 farmers and other stakeholders of different villages from Purulia district of West Bengal.

Farmers' Interaction with Scientists

4th Coordination Committee Meeting of NP-CLIGR

4th Co-ordination Committee meeting of the Network Project was held during 6-8thDecemebr 2016 at Assam Agricultural University (AAU) Jorhat. The inaugural session was inaugurated on December 06, 2016 by Dr. KM Bujarbaruah, Vice-chancellor, AAU and graced by the presence of; Dr. KK Sharma, Director, ICAR-IINRG and the Project Coordinator; Dr. GN Hazarika, OSD to VC; Dr. DK Borah, Dean, Faculty of Agriculture; Dr. C Hazarika, Director, PG School, and Dr. LK Hazarika, Organizing Secretary and PI of the AAU Center. Besides PIs and Co-PIs of the Network Project from eight Cooperating Centres, faculty and students from the host and other local institutes were also present. Dr. LK Hazarika in his welcome address mentioned the role of lac insect in shaping up the Indian civilization. Dr. KK Sharma, the Director, ICAR-IINRG and Project Co-ordinator, NPCLIGR highlighted the role of livelihood support provided by the lac insect especially in the eastern part of India. He exhorted participants that the time has come to integrate the lac in agricultural crops that has potential to increase the income per unit land by 15-20%. Chairman Dr. Bujarbaruah stressed on the need of involving similar institutions associated with conserving lac in the past *viz.* Indian Forest Research Institute, ZSI and BSI to foster the progress and increase the outreach of the project objective. He mentioned the importance of joining hand with state biodiversity authority of respective centers, for effective conservation of local lac insect collection in more scientific manner. Four Bulletins on lac were released during the inaugural session. The inaugural function ended with vote of thanks by Dr. Purnima Das, Co-PI, AAU Center. Post lunch, the delegates discussed the overall activities including progress made by the respective Centres, new sub-projects to be undertaken and future course of action of the project.

On 7th December 2016, the well established Regional Lac Insect / Host Plants Field Gene Bank at AAU Jorhat was inaugurated By Dr KK Sharma, PC of the project in the presence of all the delegates. The Project Coordinator advised the PI, Co-PI and the SRFs regarding the proper way of maintaining the lac insect and right methodology for taking observations. The delegates were also shown around the various laboratories of the Entomology Department. In the afternoon, Action Taken Report of the last Coordination Committee meeting was discussed. The PC thanked all the partners for their good performance and expressed the hope of doing better in future.

Inaugural session of of 4th Co-ordination committee meeting, NP-CLIGR

Inauguration of Lac Insect Field Gene Bank

Mera Goan Mera Gaurav (MGMG) programme

On the line of initiatives of Honb'le Union Agriculture Minister Shri Radha Mohan Singh, ICAR-IINRG adopted 8 villages under 'MGMG' programme. In Jaradih village (Block-Angarah, Distt.-Ranchi) under 'MGMG' programme 150 *ber* (*Ziziphus mauritiana*) saplings were distributed amongst the farmers for planting in the fields. Demonstration of broodlac treatment by dipping in pesticides to prevent the crop from attack of predators, parasites and fungal infection at initial stage of insect settlement was done. ETV recording of the demonstration was also done in the presence of 35 farmers. Broodlac 60 kg was distributed to 30 farmers for inoculation of *katki* crop on *palas* under field demonstration at Beradih village, Namkum Block, Ranchi. Demonstration of proper method of fertilizer application on *ber* for winter season *kusmi* lac production was organized at Mangubandh village.

Meetings of Important Committees

Institute Research Committee (IRC)

During the period under report, two IRC meetings were held, the first on April 28-29, 2016 and the second on May 07, 2016 under the Chairmanship of Dr. KK Sharma, Director, ICAR-IINRG, Ranchi. In both the meetings, 34 research projects were discussed which included 24 Institutional Projects under different core programmes, 3 Externally Funded Projects & Exploratory Studies, 3 Network Projects and 4 New Research Proposals. The following points emerged from the meeting for guidance and compliance and Chairman emphasized that each scientist must have atleast one project as PI. The House was also informed of the following:

- The suggestions / inputs from the members of IRC during deliberations were encouraging and fruitful for overall improvement of the projects, for which healthy environment needs to be maintained.
- A minimum of 50% time of the Heads of the Divisions should be devoted towards management and coordination of divisional activities.
- A copy each of project proposal, the annual progress report and the project completion report of the externally funded / sponsored projects should be submitted to PME Cell.
- Chairman, IRC, discussed the general problems and the constraints especially shortage of technical manpower faced by the scientists and assured proper redressal of the issues on merit basis.

Research Advisory Committee (RAC)

The XXIII RAC meeting was held on March 02-03, 2016 under the Chairmanship of Prof. SM Ilyas, Former Director, ICAR-NAARM, Hyderabad, in the *Kusmi* Conference Hall. The following members were present:

Prof. SM Ilyas, Former Director, ICAR-NAARM, Hyderabad	Chairman
Dr. KK Singh, ADG (Farm Engg.), ICAR, New Delhi	Member
Prof. SVS Raju, Institute of Agricultural Sciences, BHU, Varanasi	Member
Prof. VP Muthu, Head (Agri. Engg.), UAS, Bangalore	Member
Dr. AK Srivastava, Head, FMP Deptt., JNKVV, Jabalpur	Member
Dr. KK Sharma, Director, ICAR-IINRG, Ranchi	Member
Dr. S Srivastava, Pr. Sc., ICAR-IINRG, Ranchi	Member-Secretary

Invited Members

- Dr. N Prasad, Pr. Sc. & Head, PPD Division, ICAR-IINRG
- Dr. AK Jaiswal, Pr. Sc. & Head, TOT Division, ICAR-IINRG
- Dr. AK Singh, Pr. Sc. & Head, LP Division, ICAR-IINRG
- Dr. Md Monobrullah, Pr. Sc. & I/c, PME Cell, ICAR-IINRG

At the outset, Dr. KK Sharma, Director, ICAR-IINRG welcomed the Chairman and Members of the newly constituted RAC. The meeting being the first for newly constituted RAC, Director apprised them with the revised mandate and the issues relating to man-power, budget, existing infrastructure and research activities of the Institute. He also highlighted the salient achievements and the activities of the Institute completed during the year and added that the Institute had recently been accredited with IS/ ISO 9001:2008 Certification by BIS, Kolkata. He further informed the House that the new research projects were conceived based on the Vision Document, QRT and RAC Recommendations.

In his opening remarks the Chairman appreciated that Institute was progressing well in the right direction in keeping with the expanded mandate. He emphasized that the lac production and processing operations had to be adequately mechanized with the objectives of reducing the cost of production,

down-sizing the labour and drudgery. The Chairman opined that *F. semialata* was the future host plant for lac cultivation and the Institute might focus more on its R & D. The TOT activities of the Institute needed to be strengthened adopting new models, methods and ideas incorporating ICTs. He suggested that the major disciplines like Entomology, Organic Chemistry and Process Engineering need to be further strengthened for working on mission mode approach on important and relevant problems.

Dr. Md Monobrullah, Pr. Sc. & I/c, PME Cell presented the progress of all on-going institutional and externally funded projects. Dr. S Srivastava, Pr. Sc. & Member-Secretary presented the Action Taken Report (ATR) of the last RAC and after some clarifications, it was adopted. After presentation of divisions progress by the HODs, the progress of the two on-going Network Projects was presented by the Project Coordinator/ Principal Investigator. The project completion reports of the two completed projects as also four new research proposals were presented and discussed in detail. The Committee also interacted with the scientists.

The Chairman in his closing remarks expressed happiness over the excellent work being done by the scientists and asked them to keep up their zeal. He emphasized the need to encourage the basic researches on lac especially on issues that have not been addressed so far.

Dr. Kanchan K Singh, ADG felt that the research projects running at the Institute may gradually be consolidated to formulate the mega-projects having multi-disciplinary and multi-institutional approach. Prof. SVS Raju, Member RAC suggested that the lac growers must be convinced about the profitability of lac cultivation. Dr. VP Muthu, Member RAC suggested that the research divisions of the Institute need to be reorganized in the light of QRT recommendations. He further added that the mechanization of farm machinery is urgently required for making lac operation more efficient and economical. Dr. AK Srivastava, Member RAC suggested to explore the feasibility of integrating Floriculture in LIFS models developed by the Institute.

Based on the discussions and deliberations, the following recommendations were finalized:

- *Flemingia semialata* being a potential future plant for intensive lac cultivation, higher priority may be given to this plant and a study should also be undertaken on growth of *F. semialata* under alkaline and saline soil conditions for future introduction of the plant in newer areas.
- Screening of prospective quick growing host plants needs be speeded up to maximize quantity and improve quality of the lac and also for integration in the agricultural system.
- Higher priority should be accorded to basic, fundamental and strategic research.
- During washing process of sticklac, discarded wash water need be collected and recycled after purification for efficient use of natural resources.
- Process of up-gradation of the Quality Evaluation Laboratory as NABL accredited lab may be initiated and the feasibility of establishing food testing laboratory to be funded by Ministry of food processing, Govt. of India, to function as Referral Lab, may be explored.
- Identify few more centres of the Network on Harvesting, Processing and Value Addition of Natural Resins and Gums for taking up the work on processing and value addition depending on their available infrastructure and human resources.
- Develop multimedia rich training e-modules for training and transfer of technology.
- Take up case studies on evaluation /validation of technology preferably by a third party.

In the end, Dr. S Srivastava, Pr. Sc. & Member-Secretary, extended sincere thanks to the Chairman and the Members of RAC for their valuable scientific inputs to improve upon the research programmes of the Institute.

XXIII RAC Meeting in progress

Distinguished Visitors

The Institute regularly receives a number of visitors who are briefed about different aspects of natural resins and gums as well as Institute activities. List of distinguished visitors are as follows:

- Smt. Droupadi Murmu, Hon'ble Governor of Jharkhand.
- Sri Saryu Rai, Minister for Food, Public Distribution & Consumer Affairs and Parliamentary Affairs, Govt. of Jharkhand, Ranchi.
- Sri Randhir Kumar Singh, Hon'ble Minister of Agriculture & Animal Husbandry, Jharkhand.
- Sri Ram Tahal Choudhary, Hon'ble Member of Parliament, Ranchi (Jharkhand).
- Sri Ram Kumar Pahan, Hon'ble MLA, Khijri, Ranchi (Jharkhand).
- Justice (Retired) Vikramaditya Prasad, High Court, Ranchi (Jharkhand).
- Smt. Arti Kujur, Chairperson, Jharkhand State Child Right Protection Commission and Member District Board, Ranchi (Jharkhand).
- Dr. George John, Vice-Chancellor, BAU, Ranchi (Jharkhand).
- Smt. Sampat Meena, IG (Organised Crime) CID, Jharkhand.
- Sri Amarnath Mishra, Superintendent of Police, ACB Vigilance Department, Ranchi (Jharkhand).
- Mita Singh Roy, Regional Implementation Officer (NER), Ministry of Home Affairs, Guwahati (Assam).
- Sri Sanjay Bangar, Assistant Coach, Indian Cricket Team.
- Sri Bakul Gogoi, Director, Aomar Bonanee, Assam.
- Prof. SM Ilyas, Former Director, ICAR-NAARM, Hyderabad.
- Dr. KK Singh, ADG (Farm Engg.), ICAR, New Delhi.
- Prof. SVS Raju, Prof., Institute of Agricultural Sciences, BHU, Varanasi (UP).
- Prof. VP Muthu, Head (Agri. Engg.), UAS, Bangalore.
- Dr. AK Srivastava, Head, FMP Department, JNKVV, Jabalpur (MP).
- Dr. Mohan Verma, Professor and Head, Department of Space Engineering and Rocketry, Birla Institute of Technology, Mesra, Ranchi (Jharkhand).
- Sri Hue Weigh, Anning Decco Fine Chemical Co., Ltd., Kunming, China.
- Sri Swarup Dutta, Anning Decco Fine Chemical Co., Ltd., Kunming, China.
- Sri Paritosh Upadhyay (IFS), CEO, Jharkhand State Livelihood Promotion Society, Ranchi (Jharkhand).
- Sri Joan Subirats, Indukern, Spain.
- Sri Jorge Miralles, Indukern, Spain.
- Dr. Kailash Chandra, Director, Zoological Survey of India, Kolkata (WB).
- Dr. Sanjay Singh, Scientist-E and HOD, IFP, Ranchi (Jharkhand).
- Sri B Bhardwaj, DSP, CBI.
- Dr. Sharad Tiwari, Scientist, IFP, Ranchi (Jharkhand).
- Dr. RS Bana, ICAR- IARI, New Delhi.
- Dr. MS Rathi, ICAR-IARI, New Delhi.
- Ms Sanchita, JTDS, Ranchi (Jharkhand).
- Sri Suji Sancher, Euro France, SL.
- Sri Bernd Bersde, Euro France, SL.
- Sri Dayanand Rout, Assistant Director of Agriculture, Sundargarh (Odisha).
- Dr. H Sinha, Professor, Xavier Institute of Social Service (XISS), Ranchi (Jharkhand).

Support Services

Institute Research Farm (IRF)

Resource generation

Broodlac / Sticklac (Rs.)	Other Farm Produces (Rs.)	Fuel Wood (Rs.)	Water + Fuel Charges (Rs.)	Total (Rs.)
5,91,090	27,178	12,245	29,425	6,59,938

Infrastructure development

- Water storage capacity of water harvesting pond was increased to 2814 cubic meter than the existing 11200 cubic meter at Plot No. 61 of Institute Research Farm (IRF).
- Construction of urinals and wash rooms for IRF staff members.
- Developed three new experimental plots measuring size (2400 m^2, 980 m^2 and 610 m^2).
- Purchase of one heavy power tractor for IRF farm.
- More than 70 plants of the resin trees *viz*., *Pine* (15), *Dikamali* (20), Sal (5), Rubber (1) and gum trees *viz*., Neem (20), *Jhingan* (10) and *Babool* (5) were added at IRF Farm - II.

Nursery management

- The seedlings of different lac hosts were raised for gap filling and sale in large numbers.
- Seedlings of *Semialata* (6755), *Ber* (836), *Kusum* (23), *Galwang* (1) and *Khair* (2) and 1.0 kg seeds of each *Semialata* and *Galwang* were sold to farmers, KVK and other organizations.
- 1000 and 200 numbers of *Semialata* and *Khair* seedlings, respectively were transplanted for gap-filling.

Lac culture

- 3556 kg of *kusmi* brood lac of Simdega, Kulajanga, Gumla, Nawadih, Bandgaon was inoculated on *kusum* (363 Nos.) and *ber* (1000 Nos.) for both summer and winter *kusmi* crops.
- *Kusmi* broodlac 1505 kg was sold to farmers, NGO & other organizations and 955 kg was distributed to scientists for their experiments, field level demonstration and MGMG programmes.

Soil amendment

- 50 kg each *Dhaincha* and *Sanai* was sown for green manuring in *ber* (Plot Nos. 48-51) and *kusum* (Plot Nos. 40-46). In addition, *Dhaincha* and *Sanai* were raised in separate plots for seed production and yielded 100 and 25 kg each.

Bio-composting

- Pond's water gets dry quickly at Plot No. 14 (*Khair* Plot), so converted as bio-composting unit.

Maintenance

- Weeding, cleaning and lime application mixed with chloropyriphos were done on 9000 (approx.) lac host plants and other trees.

Quality Evaluation Laboratory

During the period under report a total No. of 65 customer's letter (32 outside and 33 internal), 287 samples (58 outside and 229 internal) of lac, lac-based products and natural gums were received from Govt. organizations / private industries / different divisions of the Institute and total 1415 (95 outside and 1320 internal) tests were carried out and a sum of Rs. 21837/- was earned from external sources. If the charges for the internal samples would have been fixed, more revenue for Rs. 3,11,075/- could be earned and total revenue for Rs. 3,32,912/- would be generated towards testing charges. In addition to the above, two trainees were imparted training on determination of Bleach Index of seedlac from July 20 -21, 2016.

Prioritization, Monitoring and Evaluation (PME) Cell /Institute Research Information System (IRIS) Cell

The activities performed by PME Cell & IRIS Cell during the period under report were:

- Compilation and preparation of various reports for council *viz*., Monthly Report for Cabinet Secretariat, Quarterly Performance (target-achievement) Report, Half-Yearly Progress Report (HYPR), Annual Plan and Outcome Budget Report, Matter for DARE Annual Report, information related to SMD meetings etc.
- Annual updating and presenting the report to Director, ICAR-IINRG, Ranchi for assigning research project.

- Maintaining a database on all publications.
- Coordination for publication of Institute.
- Coordination for HRD programmes for scientists and other staff members of the Institute.
- Processing of research papers / manuscripts for their publications in the Journals.
- Maintenance of research project files (both Institutional and Externally Funded Projects).
- Coordination for participation of scientists in Conference / Seminar / Symposium / Workshop and Training etc.
- Coordination for conduction of SOC, IRC and RAC meetings.
- Coordination and synthesis of recommendations of meeting *viz*. RAC, IRC, Director's Conference, Regional Committees etc.
- Processing of papers for Honors/Awards/ Recognitions of Institute's staff.
- Processing of requests under Right to Information (RTI) Act, 2005.
- Providing LAN and Internet connectivity to divisions and sections of the Institute.
- Maintenance of web-based database for Personnel Management Information System (PERMISNET), ICAR-Enterprise Resource Planning (ERP), Project Information Management System (PIMS-ICAR) and Half-Yearly Progress Monitoring (HYPM) System for the scientists.
- Hosting of websites for ICAR-IINRG, ICAR-IIAB, SANRAG and two Network Projects and regular updating of these websites (General information, Events, Tenders, Walk-in-interview) from time to time.
- The projection systems in *Kusmi* Conference Hall have been upgraded.
- Configuration, installation and monitoring of Aadhaar Enabled Biometric Attendance System (AEBAS) in three divisions and other seven locations at ICAR-IINRG. Since AEBAS is an online system, internet connectivity from all service providers is supported in AEBAS.
- Installation of Video Surveillance System in the running cable between the various camera locations and the Digital Video Recorder (DVR). Actively used video surveillance equipment, including the 36 cameras got assembled, mounted, configured and connected in place at different locations.
- PME Cell presently maintains three servers namely, proxy server for providing internet connectivity to divisions/sections, Mail server for providing e-mail facilities and Apache web server for hosting websites.

Library and Documentation Centre

The library of the Institute plays an important role in meeting the information needs of its user. The library is a repository of scientific and technical information on natural resins and gums. Besides catering to the needs of Institute scientists it also render services to other researchers, academicians, technologists and students as also lac/gums/resins industrialists from other part of the country. The library maintained adequate linkages with leading reference libraries for strengthening the information resources. The library also supplies photocopies of rare research articles to NISCAIR, New Delhi, time to time against payment. Advance/Full Text/Abstracts access of more than 3400 Journals from several publishers has been made available online through Consortium for e-Resources in Agriculture (CeRA) to our scientists during the year. An amount of Rs. 13,494/- was generated, as revenue, from the sale of publications and reprographic services during the year. The library also continued to exchange Institute publications with the scientific institutions in and out side the country.

Services provided by the Library to its users

- E-Journals access
- CD Searches
- Document Delivery Services
- Reprographic Services
- Bibliographic Services
- Current Awareness Services
- Inter Library Loan Services for resource sharing
- Sale and distribution of Institute publications.

Journals & periodicals subscribed / received

Foreign Periodicals (Subscribed)	02
Foreign Periodicals (Gratis/exchange)	05
Indian Periodicals (Subscribed)	07
Indian Periodicals (Gratis/exchange)	11

Library holdings (as on 31.12.2016)

Documents	Additions	Total Holdings
Books	-	7953
Bound Journals	31	21692
Annual Report	82	5290
CD- Rom	-	123
IS-Specification	-	184
Maps	-	37
Patents (Foreign)	-	327
Patents (Indian)	-	15
Thesis	1	14

Estate Section

Estate section is one of the most important units of the Institute which takes care of the following essential services:

- Security of Institute premises – No major security lapse occurred
- Water and power supply
- Infrastructure development work of the Institute
- Providing assistance in the engineering research work
- Civil & electrical maintenance of residential quarters and office buildings
- General maintenance & up-keep of Institute premises. The work is being outsourced and monitored by the Estate Management Committee.

Registration of jobs

Jobs registered in the various job registers during the Calendar Year 2016 are:

- Electrical work 712
- Civil & water supply 401 (this includes plumbing & other civil works)
- Carpentry works 458
- Turner works 590
- Welder works 190

Most of the above works have been completed satisfactorily, however, some of them could not been done due to scarcity of resources which will be initiated in near future.

Work taken up through CPWD

- Renovation of quarters Type IV (3 to 10)
- Renovation of quarters Type III (18 to 29)
- Roof treatment of quarters Type IV (5 & 6)
- Extension of PPD Division
- Extension of LP Division
- Renovation of transformer room
- Renovation of IRF building (civil as well as electrical)
- Renovation of water supply pipe line
- Internal repair & miscellaneous civil work in TOT Division
- Renovation of Director's Office
- Renovation of Bungalow No.1
- Renovation of Guest House.

Major works carried out departmentally

- Maintenance of street lights in serviceable condition throughout the year.
- Maintenance of electrical installation of residential quarters and divisions / sections in operational condition throughout the year.
- Maintenance of Genset and associated panels, transformer, overhead LT lines in operational condition throughout the year.
- Installation of 45 W LED street lights in PDU campus in place of CFL street lights.
- Restoration of power supply in main campus & PDU campus in shortest possible time after breakdown of power supply due to storm on 08.3.2016, 12.5.2016, 28.5.2016 and 12.6.2016 after removal of branches from overhead lines and restraining of overhead lines.
- Painting and numbering of tubular electrical poles in main campus, PDU campus and IRF.
- Repairing of power cable of *Palas* Conference Hall which was damaged by JCB.
- Painting of both 75 KVA DG set.
- Pastering of court yard of quarters Type-III /8 and Type-II(15-24).
- Distempering of quarters Type-III (14-16) in PDU campus.
- Plastering of walls and floors, distempering of inner wall and weather coat of external walls of workshop of PD Unit.

Commitments for the Year 2017

- Renovation of Main gate complex along with waiting lounge, reception counter, security office and sale counter.
- Enhancement of capacity of existing transformer numbering two of 400 KVA with associated panels and earthing.
- Extension of ICAR- IINRG Museum.
- Raising the height of boundary wall.
- Renovation of road in the Main campus/PDU campus along with proper drainage system.
- Electrical renovation of Pilot Plant Building.
- Renovation of old Guest House and *Kisan* Hostel.
- Installation of cassette Air conditioner in *Palas* Conference Hall.
- Renovation of Lac Scraping Shed.
- Expansion of Library Building.
- Construction of storage tank and irrigation facility in IRF.
- Renovation of Estate section building.

Health Center

The Institute has a functional Health Center in the campus. Dr. Ashok Kumar and Dr. Kailash Prasad have been functioning as a part time Medical Officers (AMAs) on contractual basis on alternate days in the center. Most of the medical cases were handled in the center itself and complicated cases referred to authorized hospitals and pathology clinics in the city for expert diagnosis and treatment. The health center is equipped with routine instruments to handle general /minor dressing, first aid, physical examination of patients, measure B.P., pulse, height, weight, blood sugar, etc. During the year 2016, 7,282 patients were registered and treated in the health center. Around 206 patients were monitored for blood sugar by test strips method in the center itself as per the advice of AMAs. The center has a computerized inventory system, facilitating retrieval of records like issue of medicine, date of receiving, unregistered patient, along with the near date of expiry of medicine, etc. This ultimately helps the AMAs in taking better decision while prescribing medicines. Most of the medicines prescribed by AMAs were made available to the patients from the health center itself. Apart from attending to regular employees, pensioners, and contractual staff of various on-going research projects, medical treatment were also provided to trainees and laborers on humanitarian grounds, in case of emergency and casualty.

During the Year under report, doctor's chambers, patients' waiting hall and toilets were given face-lift by placing various informative signages. Digital clock and steel three-in-one waiting chairs were also fitted in the premises, for convenience of patients waiting in queue.

IPR / ITMU

- Participation of ITMU in Institute's Annual *Kisan Mela,* 2016 and demonstration of technologies.
- Preparation of poster materials numbering six in bilingual of Institute technologies and sent to ADG (Engg.), ICAR, New Delhi for display in *Krishi Unnati Mela* , 2016 at New Delhi.
- Preparation of list of technologies and details of commercialized/licensed and sent to DG, ICAR, New Delhi.
- Provisional patent application of lac wax Policosanol, A natural plant growth regulator, was filed in Kolkata patent office (Application No. 201631013579) through Attorny M/s Anjan Sens & Associates on 19.4.2016.
- Sent Annual achievement of ITMU, ICAR-IINRG for 2015-16 to ZTMC, ICAR-CIAE, Bhopal.
- Sent achievement of ITMU, ICAR-IINRG for the period 2014-16 for compilation and presentation in Ministry by IP&TM Unit ICAR.
- Preparation of technology details of recovery of lac dye in power point and sent to ADG (Engg.), ICAR, New Delhi for its presentation in National Seminar at Sikohpur, Gurgaon.
- Compilation and submission of details of seven ICAR-IINRG lac based technologies and sent to Agrinnovate India (AGIN) for possible commercialization.
- Preparation & submission of information on technology transfer/commercialization of ICAR-IINRG for the period November 2015 to October 2016 for inclusion in DARE/ICAR Annual Report.
- Prepared expenditure statement and sent to IP&TM Headquarter.
- Revised/compiled Institute technology details in bilingual (Hindi & English) for printing as extension material in flex/poster for presentation in different events.

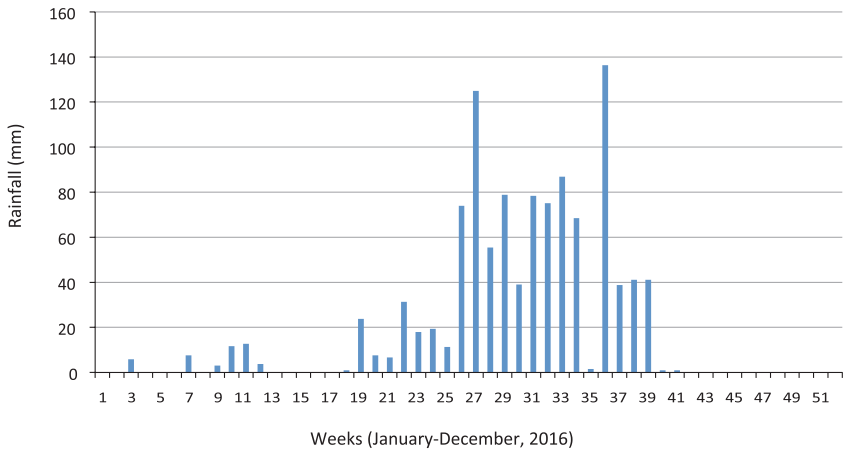
Agro-meteorology Unit

Agro-meteorology Unit of the Institute is situated at 23^0 23'N latitude, 85^0 23'E longitude at 650 m altitude. During the year 2016, different weather parameters were recorded and updated daily as well as weekly at the Institute website. Daily Self Recording Rain Gauge (SRRG) sheets and daily rainfall data for the year was sent to India Meteorological Department, Kolkata. The monthly mean relative humidity (RH %), mean temperature (^{0}C) and total rainfall (mm) is given in the Table. Weekly analysis of rainfall has been presented in Figure. Analysis of data for these parameters revealed significant variations amongst months.

During July, relative humidity (RH) was the maximum at 8:30 hours (92.06%), with 88.77 per cent in the 14:30 hours, while the minimum RH was observed for the month of October (Table). Maximum temperature for the year was recorded on 19th, 26th, 27th April and 15th May (40.5 ^{0}C), while the minimum temperature was on 25th January (2.5 ^{0}C). Hottest and coldest months of the year were April and January with mean monthly temperature 38.71^{0}C and 6.12 ^{0}C, respectively. Total annual rainfall was 1105.60 mm. It is pertinent to say that 4th July received maximum rainfall ***i.e.*** 85 mm. Maximum monthly rainfall was observed in July (332.50 mm), where as no rainfall occurred in April, November and December of the Calendar Year 2016.

Meteorological data recorded at the Agro- meteorology Unit of the Institute during 2016

Month, 2016	Mean Relative Humidity (%)		Mean Temperature (^{0}C)		Rainfall (mm)
	08:30 hrs	14:00 hrs	Minimum	Maximum	
January	81.26	67.45	6.12	23.69	5.80
February	84.61	68.07	11.78	28.08	10.70
March	74.55	65.35	14.58	31.90	28.20
April	67.30	64.30	20.69	38.71	0.00
May	75.23	68.48	20.85	36.21	63.90
June	83.40	80.93	22.33	32.78	129.10
July	92.06	88.77	21.40	28.01	332.50
August	90.29	88.97	21.08	28.34	276.10
September	83.43	79.77	21.05	28.54	257.30
October	62.81	61.48	15.99	29.33	2.00
November	69.03	65.53	9.47	25.98	0.00
December	75.10	65.10	6.47	23.85	0.00
				Total Annual Rainfall (mm)	**1105.60**



Weekly distribution of rainfall for the year, 2016

KVK, Khunti, ICAR - IINRG

About KVK

Foundation for 23rd KVK of Jharkhand at Diyankel, Torpa, Khunti was laid on May 05, 2014. KVK, Khunti is under the administrative control of ICAR-IINRG, Ranchi. Demarcation / acquisition work of the land area 49.19 acre was delayed due to payment problems between farmers and DCLR, Khunti. Dr. SP Singh, Programme Coordinator, KVK joined at ICAR-IINRG, Ranchi on 1st January, 2016. Demarcation work of land for KVK was completed in February, 2016. Trenching on boundary of the KVK land is done. Recruitment of SMS/Scientists and staff for KVK, Khunti is in process. Two training programmes (i) Awareness Training on Protection of Plant Varieties and Farmers' Rights Act, 2001 and (ii) Farmers' Fair-cum-Awareness Programme on '*Pradhan Mantri Fasal Beema Yojna'* (PMFBY) were organized on March 29, 2016 and April 13, 2016 respectively.

Awareness Training on Protection of Plant Varieties and Farmers' Rights Act, 2001 organized by ICAR-KVK, Khunti at Torpa

KVK, Khunti under ICAR-IINRG organized awareness training on 'Protection of 'Plant Varieties and Farmers' Rights Act, 2001' on March 29, 2016 at Mahila Vikas Kendra, Torpa, Khunti, Ranchi. The Chief Guest, Shri Jaya Mangal Gudiya, Member of Zila Parishad, Torpa; Sister Daphne Sequeira, Director, TRDS; Dr. KK Sharma, Director, ICAR-IINRG, Ranchi and Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti inaugurated the function by lighting the lamp. In his welcome address, Dr. SP Singh briefed the importance of Protection of Plant Varieties and Farmers' Rights Act, 2001 and role of Protection of Plant Varieties and Farmers' Rights Authority.

The Chief Guest, Shri Gudiya appreciated the activities of KVK Khunti and as a proactive local representative, he asked the farmers for participation in these awareness programmes to harness the benefits of farm sector schemes. On the set up of new KVK in Khunti, he also told about the importance of the quantum of knowledge, training and experience. This process of learning and doing things impart the experience based on the field condition leading to emergence of different innovations.

In his presidential remark, Dr. KK Sharma, Director, ICAR-IINRG emphasized on the importance of the Act, which protects the farmers' rights and provide the opportunities for local ownership. He suggested that any local important plant or plant material may be protected through this act and KVK Khunti will be guiding agency for the interested local farmers.

During various technical sessions, the experts and scientists of the ICAR-IINRG, Ranchi presented the detailed scope of the Protection of Plant Varieties and Farmers' Rights Act, 2001. They also interacted with farmers and various issues related to Protection of Plant Varieties and Farmers' Rights Authority was discussed. About 200 farmers/stakeholders participated in the training-cum-awareness programme. The programme was sponsored by the Protection of Plant Varieties and Farmers' Rights Authority, Ministry of Agriculture and Farmers Welfare, Govt. of India. Dr. RK Yogi, Sc. & Co-convener of the function presented vote of thanks.

Dr. KK Sharma, Director, ICAR-IINRG addressing the participants

Farmers' Fair-cum-Awareness Programme on *Pradhan Mantri Fasal Beema Yojna* at KVK, Khunti

Farmers' Fair-cum-Awareness Programme on *Pradhan Mantri Fasal Beema Yojna* (PMFBY) was organised by KVK, Khunti of ICAR-IINRG on April 13, 2016. Chief Guest Hon'ble Member of Parliament, Khunti Shri Kariya Munda inaugurated the Farmers' Fair. He briefed about the modification of old *Fasal Beema Yojna* and the start of *Pradhan Mantri Fasal Beema Yojna* to be effective from *Kharif* -2016 and requested farmers to get insured their crops to protect from the risks. A booklet on '*Bharat Sarkar Ki Krishi Sambandhi Yojnayen*' was released by the Chief Guest and was distributed amongst farmers and state officials.

Dr. KK Sharma, Director briefed about the PMFBY to be implemented from coming *Kharif* season and emphasized on the benefits of PMFMY to the farmers.

Dr. SP Singh, Head, KVK, Khunti briefed about the different Agricultural Schemes of Govt. of India. Dr. RK Yogi, Sc. and Mrs. Jagmani Topno, Assistant Registrar (Cooperative), Khunti interacted with farmers on PMFMY in detail and answered their queries. Technical Session on improved technologies and Farmers-Scientists interaction was also conducted after the inaugural session. Dr. AK Singh, Dr. SP Singh, Dr. SR Meena, Dr. RK Yogi and Sri DK Singh briefed on the technologies and answered the queries of farmers. More than 200 farmers attended the programme.

Ms Roshni Gudiya, Block Pramukh, Ms Sofiya Sultaan, Deputy Block Pramukh along with other Public Representatives, District/Block level Govt. Officers, Private and NGO'S Representative attended the programme. Dr. AK Jaiswal, Head, TOT Division, ICAR-IINRG presented the vote of thanks.

Chief Guest Hon'ble Member of Parliament, Khunti Shri Kariya Munda ji addressing the participants

Participation in *Kisan Mela*/Exhibition/Interface Meeting by Head, KVK

- Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti, participated in second day of 38th Central Shri Ramkrishan *Kisan Mela* on '*Swasthya Mitti-Swasthya Fasal-Swsthya Samaj*' organised by RMA Divyayan KVK, Morabadi, Ranchi at Getalsuth Farm, Angada, Ranchi on January 28-29, 2016. Attented a Kisan Gosthi/ Farmers-Scientists interation and replied the questions of the farmers.
- Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti, attended 'International Women's Day' organised by TRDS, Torpa on March 9, 2016 and also delivered a lecture titled, 'Role of Women in Agriculture'.
- Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti, participated and displayed technologies developed by ICAR-IINRG during *Krishi Unnati Mela* - 2016, ICAR-IARI, New Delhi, March 19-21, 2016. Hon'ble Prime Minister of India inaugurated the *mela*. Thousands of farmers, entrepreneurs visited the stall.
- Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti, attended meeting of Heads of KVKs, DAOs and other Govt. Officials of Agriculture Departmets of Jharkhand called by Chief Secretary, Govt. of Jharkhand, June 04,2016.
- Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti, attended meeting of Heads of KVKs called by Vice Chancellor, BAU, Ranchi, June 04, 2016.
- Dr. SP Singh, Sr. Sc. & Head, KVK, Khunti, attended Review Workshop on CFLD of Pulses and Oilseeds at DEE, BAU, Ranchi, December 21, 2016.

Publications

- Singh, SP (2016). *Paudha Kism Aur Krishak Adhikar Sanrakshan*. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, p. 39.
- Singh, SP (2016). *Bharat Sarkar Ki Krishi Sambandhi Yojnayen*. ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Bulletin No. 02/2016, p. 19.

HRD

- Dr. SP Singh, Sr. Sc. & Head did moderation of question paper of Agriculture for the ICAR's All India Entrance Examination (AIEEA-UG-2016) for Admission to UG Programmes in Agricultural Universities as well as award of National Talent Scholarships, February 05-06, 2016.
- Dr. SP Singh, Sr. Sc. & Head was deputed to Agricultural Education Division, ICAR HQ from June 23-30, 2016 for preparation of seat metrics for the purpose of counseling for admission of candidates qualified in AIEEA-UG, PG and Ph.D. examinations.
- Dr. SP Singh, Sr. Sc. & Head participated and successfully completed 4th Management Development Programme for newly recruited PCs of KVKs at ICAR-NAARM, Hyderabad from April 22–May 06, 2016; KVK, Gurgaon from May, 11-20, 2016 and at ICAR-ATARI, Kolkata from May 23-27, 2016.

संस्थान के राजभाषा प्रकोष्ठ की गतिविधियां

भारत सरकार के राजभाषा विभाग (गृह मंत्रालय) द्वारा तैयार किए गए वार्षिक कार्यक्रम एवं राजभाषा अधिनियम व नियमों के संबंध में भारतीय कृषि अनुसंधान परिषद, नई दिल्ली से समय-समय पर प्राप्त निर्देशों पर अनुवर्ती कार्रवाई तथा सरकारी कार्य में हिन्दी के प्रयोग को और गति प्रदान करने के लिए संस्थान में राजभाषा प्रकोष्ठ की स्थापना की गई है। इसमें एक वरिष्ठ तकनीकी अधिकारी (रा.भा.), एक अंशकालीन टंकक तथा एक अंशकालीन पदचर कार्यरत हैं। संस्थान में राजभाषा संबंधी क्रिया-कलापों की समीक्षा के लिए संस्थान के निदेशक की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति गठित की गई है, जिसमें विभागों/अनुभागों के अध्यक्ष, सदस्य के रूप में शामिल हैं तथा वरिष्ठ तकनीकी अधिकारी (रा.भा.) सदस्य सचिव हैं ।

संस्थान 'क' क्षेत्र में है तथा इसे राजभाषा अधिनियम की धारा 10(4) के अर्न्तगत केन्द्रीय गजट में अधिसूचित किया जा चुका है। संस्थान के सात अनुभागों को शत प्रतिशत कार्य हिन्दी में करने हेतु विनिर्दिष्ट किया गया है एवं प्रवीणता प्राप्त सभी अधिकारियों/कर्मचारियों को अपना-अपना कार्य हिन्दी में करने हेतु व्यक्तिशः आदेश दिये गये हैं। राजभाषा नियम के प्रावधानों के अनुपालन एवं दैनिक कार्य में हिन्दी के प्रयोग में प्रगति लाने तथा इसे सर्वग्राह्य बनाने के लिए राजभाषा प्रकोष्ठ द्वारा निम्नलिखित कार्य सम्पादित होते हैः-

संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी तथा बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई। वार्षिक रिपोर्ट के हिन्दी संस्करण का प्रकाशन, राजभाषा की वार्षिक पत्रिका लाक्षा का प्रकाशन, कार्यालय आदेश, परिपत्र, ज्ञापन, निविदा इत्यादि एवं पत्राचार हेतु विभिन्न सामग्रियों का आवश्यकतानुसार अनुवाद। हिन्दीतर अधिकारियों और कर्मचारियों को हिन्दी शिक्षण योजना द्वारा आयोजित प्रशिक्षण एवं नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों द्वारा आयोजित विभिन्न हिन्दी प्रतियोगिताओं एवं कार्यशालाओं में सहभागिता हेतु प्रेरित करना।

संस्थान के दैनिक कार्य में हिन्दी के प्रयोग में प्रगति एवं इसे सरल बनाने के लिए राजभाषा प्रकोष्ठ द्वारा निम्नलिखित कार्य सम्पादित होते हैं:

- संस्थान राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी एवं बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई ।
- वार्षिक रिपोर्ट के हिन्दी संस्करण एवं वार्षिक राजभाषा पत्रिका लाक्षा का प्रकाशन, भा.प्रा.रा.गों.सं. समाचार पत्रिका, कार्यालय आदेश, परिपत्र, ज्ञापन, निविदा, सूचना एवं पत्राचार हेतु विभिन्न सामग्रियों का अनुवाद।
- अधिकारियों और कर्मचारियों को नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों द्वारा आयोजित विभिन्न हिन्दी प्रतियोगिताओं एवं कार्यशालाओं में सहभागिता हेतु प्रेरित करना ।
- हिन्दी दिवस, हिन्दी चेतना मास एवं योजनानुसार नगर स्तरीय राजभाषा संबंधी, संगोष्ठी एवं कार्यशाला का आयोजन करना।
- संदर्भ साहित्य, हिन्दी पत्रिका, शब्दकोश एवं तकनीकी शब्दावली के उपार्जन हेतु कार्य
- द्विभाषी मुहरों, नामपटट के निर्माण अथवा सक्रिय सहयोग करना।
- प्रचार सामग्रियों के हिन्दी रूपान्तर एवं समारोहों के समाचार संकलन एवं मीडिया प्रबंधन का कार्य
- विभागीय विषय पर तकनीकी शब्दावली का निर्माण ।
- हिन्दी में वैज्ञानिक गोष्ठी के साथ-साथ प्रशासनिक तथा तकनीकी वर्ग के लिए कार्यशाला का आयोजन।
- निदेशक महोदय की अध्यक्षता में वर्ष 2016 में संस्थान राजभाषा कार्यान्वयन समिति की निर्धारित चार तिमाही बैठकों का आयोजन निम्नलिखित तिथियों को किया गया तथा प्रगति की समीक्षा की गई। तिमाही रिपोर्ट एवं कार्यवृत परिषद सहित अन्य संबंधित कार्यालयों में प्रेषित की गई :

  (क) दिनांक 27.02.2016

  (ख) दिनांक 06.6.2016

  (ग) दिनांक 05.8.2016

  (घ) दिनांक 23.11.2016

जिसके अर्न्तगत निम्नलिखित प्रमुख चर्चायें हुईं तथा सर्वसम्मति से निर्णय लिए गए :-

- संस्थान में हिन्दी में मूल रूप से पत्राचार बढ़ाने के लिए नकद पुरस्कार योजना का अनुपालन।

- वार्षिक कार्यक्रम 2015-16 एवं 2016-17 के प्रस्ताव पर चर्चा ।
- गृह पत्रिका लाक्षा-2016 का प्रकाशन।
- वर्ष-2016-17 के लिए नकद पुरस्कार योजना लागू करना एवं वर्ष-2015-16 के प्रतिभागियों के लिए पुरस्कार का निर्धारण।
- नगर स्तरीय हिन्दी संगोष्ठी/कार्यशाला का आयोजन
- स्वास्थ्य संबंधी विषय पर हिन्दी कार्यशाला/व्याख्यान का आयोजन।
- द्विभाषी मुहरों का निर्माण।
- द्विभाषी नामपट्ट की व्यवस्था।
- लाक्षा 2015 के सर्वश्रेष्ठ आलेख का चयन एवं पुरस्कार
- हिन्दी दिवस/हिन्दी प्रतियोगिताओं का आयोजन।
- प्रवीणता प्राप्त सभी अधिकारियों/कर्मचारियों को व्यक्तिशः आदेश जारी करना
- सभी कम्प्यूटरों में यूनिकोड या गुगल हिन्दी सॉफ्टवेयर की व्यवस्था
- अनुवाद के लिए आउटसोर्सिंग
- हिन्दी पुस्तकों का उपार्जन
- जाँच-बिन्दु का निर्धारण।
- राजभाषा नियम 8(4) के अन्तर्गत संस्थान के सात अनुभागों को सम्पूर्ण कार्य हिन्दी में करने हेतु विनिर्दिष्ट करना।

राजभाषा प्रकोष्ठ की उपलब्धियां-2016

- "प्राकृतिक राल एवं गोंद- भा.प्रा.रा.गों.सं. समाचार पत्रिका" का सम्पूर्ण अनुवाद एवं आउटसोर्सिंग द्वारा सम्पूर्ण वार्षिक रिपोर्ट का अनुवाद कराया गया।
- संस्थान की वार्षिक हिन्दी पत्रिका लाक्षा-2016 का प्रकाशन किया गया।
- संस्थान के आगत-निर्गत पत्रों का विस्तृत (अनुभाग/विभाग व क्षेत्रवार) विवरण तैयार कर विहित प्रपत्र में तिमाही रिपोर्ट तैयार की गयी तथा परिषद् समेत सभी संबंधित कार्यालयों को प्रेषित की गयी।
- वैज्ञानिक उपकरणों से जुड़े कम्प्यूटरों को छोड़कर संस्थान के कुछ अन्य कम्प्यूटरों में हिन्दी फॉन्ट लगा दिये गये हैं तथा ज्यादातर कम्प्यूटरों में युनीकोड/गुगल हिन्दी सॉफ्टवेयर डाला गया है।
- समय-समय पर हिन्दी के प्रयोग को प्रोत्साहित करने के लिए विभिन्न प्रकार की हिन्दी प्रतियोगिताओं का आयोजन किया गया।
- हिन्दी में श्रुतिलेखन (डिक्टेशन) देने के लिए पुरस्कार योजना संस्थान में लागू की गई है।
- लाक्षा-2015 के सर्वश्रेष्ठ आलेख के चयन के लिए कमिटी गठित कराई गई तथा सर्वश्रेष्ठ आलेख का चयन कर लेखकों को पुरस्कार प्रदान किया गया।
- सरकारी काम काज मूल रूप से हिन्दी में करने हेतु संस्थान में नकद पुरस्कार योजना लागू की गई, इसमें तकनीकी एवं प्रशासनिक वर्ग के कुल 09 अधिकारियों /कर्मचारियों को पुरस्कार प्रदान किए गए।

कार्यक्रम

हिन्दी चेतना मास/हिन्दी दिवस समारोह-2016

राजभाषा अधिनियम के अनुपालन एवं कार्यालय कार्य में राजभाषा हिन्दी के प्रयोग में उत्तरोत्तर वृद्धि के लिए संस्थान में दिनांक-01.09.2016 से 30.09.2016 तक हिन्दी चेतना मास का पालन किया गया तथा दिनांक-01.10.2016 को अपराह्न 02.30 बजे चेतना मास के समापन समारोह के रूप में हिन्दी दिवस समारोह का आयोजन किया गया।

हिन्दी दिवस समारोह के अवसर पर मुख्य अतिथि के रूप में उपस्थित न्यायमूर्ति श्री विक्रमादित्य प्रसाद, अवकाश प्राप्त न्यायाधीश, राँची उच्च न्यायालय ने न्यायालयों में हिन्दी के प्रयोग की स्थिति विषय पर बोलते हुए कहा कि न्यायपालिका में हिन्दी के बजाय अंगरेजी का अधिक प्रयोग हो रहा है। इसका एक कारण यह भी है कि उच्च न्यायालय एवं सर्वोच्च न्यायालय में न्यायाधीश भारत के विभिन्न भागों से आते हैं तथा उनके लिए हिन्दी में काम करना सहज नहीं होता। न्यायिक साहित्य की दृष्टि से भी हिन्दी में पुस्तकों की उपलब्धता कम है। श्री प्रसाद ने कहा कि साहित्य ऐसा होना चाहिए जो पढ़नेवाले की सोच को प्रभावित कर सके। हिन्दी के विकास के लिए प्रत्येक क्षेत्र के लोगों को अंगरेजी का मोह छोड़कर इसे अपनाने के लिए पहल करना होगा। उन्होंने वैज्ञानिकों को हिन्दी में लिखने एवं रोजमर्रा के कामों में हिन्दी की सरलता और सहजता को अपनाने की अपील की।

इस अवसर पर विशिष्ट अतिथि के रूप में उपस्थित डॉ संजय सिंह साहित्यकार एवं वैज्ञानिक ई व विभागाध्यक्ष, वन उत्पादकता संस्थान, नगड़ी, राँची ने वैज्ञानिक साहित्य में हिन्दी के प्रयोग की स्थिति पर बोलते हुए कहा कि पहले से स्थितियां अब थोड़ी बदली है। ढेर सारे वैज्ञानिक आलेख अब हिन्दी में लिखे जा रहे हैं तथा विज्ञान से जुड़े कई जर्नल अब हिन्दी में निकल रहे हैं। आवश्यकता है हिन्दी में मौलिक लेखन के प्रोत्साहन की। उन्होंने हिन्दी के प्रयोग को प्रोत्साहित करने के लिए सरल हिन्दी के प्रयोग पर जोर दिया।

संस्थान के निदेशक, डॉ केवल कृष्ण शर्मा ने अपने स्वागत भाषण में कहा कि हिन्दी चेतना मास के समापन समारोह के रूप में हिन्दी दिवस समारोह का आयोजन किया गया है। संस्थान में लम्बे समय से राजभाषा हिन्दी का प्रयोग होता रहा है। हमारे यहाँ कार्यालय कार्य के साथ-साथ वैज्ञानिक साहित्य में भी हिन्दी का अच्छा प्रयोग हो रहा है। संस्थान द्वारा नियमित अंतराल पर हिन्दी/द्विभाषी पुस्तिकाएं, पत्रक इत्यादि प्रकाशित होते रहते हैं। डॉ. शर्मा ने कहा कि न सिर्फ हिन्दी में बल्कि संस्थान द्वारा राज्य की स्थानीय भाषा एवं बांग्ला व उड़िया में भी कृषि संबंधी प्रसार साहित्य संस्थान द्वारा प्रकाशित किये गये हैं। संस्थान में केवल हिन्दी चेतना मास में ही नहीं, सामान्य एवं दैनिक कार्यों में भी नियमित रूप से राजभाषा का प्रयोग किया जाता है। उन्होंने कहा कि हमारा पुस्तकालय वैज्ञानिक साहित्य की दृष्टि से बहुत समृद्ध है, साथ ही यहां प्रचूर संख्या में हिन्दी की पुस्तक/पुस्तिकाएं उपलब्ध हैं। इस अवसर पर संस्थान की वार्षिक राजभाषा पत्रिका लाक्षा-2016 का लोकार्पण भी किया गया।

हिन्दी चेतना मास की अवधि में दिनांक-08-09 सितम्बर 2016 को हिन्दी टिप्पण, प्रारूप लेखन, निबंध, अंताक्षरी, पर्याय, व्याख्यान, पर्यायवाची शब्द एवं विपरीतार्थक शब्द प्रतियोगिताओं का आयोजन किया गया। डॉ. एम ज़ेड सिद्दीक़ी, श्री प्रहलाद सिंह, श्री बिनोद कुमार, श्री अनिल कुमार सिन्हा, श्री कृष्ण मुरारी कुमार, डॉ अनिस के, श्री शरत चन्द्र लाल, श्री अश्विनी कुमार, श्री मान्देश्वर सिंह, श्री बैजनाथ महतो, श्री जलेश्वर महतो, श्री चैतु कच्छप इत्यादि को पुरस्कार प्रदान किया गया। इसके साथ ही समारोह में लाक्षा-2015 में उत्कृष्ठ आलेख का पुरस्कार डॉ. निरंजन प्रसाद, विभागाध्यक्ष, डॉ. छाया, आर.ए., श्री अमित कुमार कर, आर.ए. को प्रदान किया गया।

कार्यक्रम का संचालन डॉ अंजेश कुमार, वरिष्ठ तकनीकी अधिकारी एवं धन्यवाद ज्ञापन श्री नन्द किशोर ठोंबरे, वैज्ञानिक एवं अध्यक्ष हिन्दी दिवस समारोह आयोजन समिति ने किया।

इस अवसर पर अन्य संस्थानों के अतिथियों के अतिरिक्त संस्थान के सभी अधिकारियों/कर्मचारियों ने भाग लिया।

संस्थान के हिन्दी/द्विभाषी प्रकाशनों की सूची

- प्राकृतिक राल एवं गोंद, भा.प्रा.रा.गों.सं. समाचार पत्रिका, अक्टूबर 2015-सितम्बर 2016, अंको की संख्या- 04, पृष्ठों की संख्या-36 (द्विभाषी)
- ईयर प्लानर-सह-प्रचार पत्रक 2016 पृष्ठों की संख्या 28 (द्विभाषी)
- लाक्षा-2016, पृष्ठों की संख्या-110

राजभाषा पत्रिका लाक्षा-2016 का लोकार्पण

Budget

Budget allocation and utilization during 2016-17

(Rs. In Lakhs)

Sl. No.	Name of the Head	Plan		Non Plan	
		R.E. 2016-17	Exp. during 2016-17	R.E. 2016-17	Exp. during 2016-17
GRANT FOR CREATION OF					
1	Works				
	(A) Land	0.00	0.00	0.00	0.00
	(B) Building	0.00	0.00	0.00	0.00
	i. Office Building	101.00	101.00	0.00	0.00
	ii. Residential Building	0.00	0.00	0.00	0.00
	iii. Minor Works	0.00	0.00	0.00	0.00
2	Equipments	35.93	35.89	5.00	4.90
3	Information Technology	2.56	2.35	0.00	0.00
4	Library Books & Journals	0.01	0.01	0.00	0.00
5	Vehicle & Vessels	0.00	0.00	0.00	0.00
6	Live Stock	0.00	0.00	0.00	0.00
7	Furniture & Fixtures	0.00	0.00	2.00	2.00
8	Others	0.00	0.00	0.00	0.00
	Total Capital (Grants for creation of capital assets)	**139.50**	**139.25**	**7.00**	**6.90**
GRANT IN AID SALARIES (REVENUE)					
1	Establishment Expenses				
	(A) Salaries				
	i Establishment charges	0.00	0.00	1200.00	1029.97
	ii. Wages	0.00	0.00	0.00	0.00
	iii. Over Time Allowance	0.00	0.00	0.25	0.23
	Total Estt. expenses (grant in Aid-Salaries)	**0.00**	**0.00**	**1200.25**	**1030.20**
GRANT IN AID GENERAL (REVENUE)					
1	Pension & Other Retirement Benefits	0.00	0.00	300.00	268.50
2	Travelling Allowances				
	(A) Domestic TA/ Transfer TA	6.00	5.82	6.00	5.99
	(B) Foreign TA	0.00	0.00	0.00	0.00
	Total Travelling expenses	**6.00**	**5.82**	**6.00**	**5.99**
3	Research & Operational Expenses				
	(A) Research Expenses	23.00	22.85	13.00	12.98
	(B) Operational Expenses	6.74	6.44	8.00	7.99
	Total Res. & Operational expenses	**29.74**	**29.29**	**21.00**	**20.98**
4	Administrative Expenses				
	(A) Infrastructure	20.50	19.54	35.00	34.86
	(B) Communication	0.00	0.00	3.00	2.88
	(C) Repairs & Maintenance				
	i. Equipments, Vehicle & Others	0.00	0.00	20.00	15.18

Sl. No.	Name of the Head	Plan		Non Plan	
		R.E. 2016-17	Exp. during 2016-17	R.E. 2016-17	Exp. during 2016-17
	ii. Office Building	25.76	25.76	35.00	34.85
	iii. Residential Building	10.00	10.00	15.00	14.87
	iv. Minor Works	0.00	0.00	0.00	0.00
	(D) Others Admin. Expenses	0.00	0.00	45.75	45.26
	Total Administrative Expenses	**56.26**	**55.30**	**153.75**	**147.90**
5	Miscellaneous Expenses				
	(A) HRD	3.00	2.88	0.00	0.00
	(B) Other Items (Fellowship/ Scholarship etc.	0.00	0.00	0.00	0.00
	(C) Publicity & Exhibitions	4.50	3.27	2.00	1.88
	(D Guest House Maintenance	0.00	0.00	1.00	0.99
	(E) Other Miscellaneous	38.00	37.24	5.00	4.98
	Total Misc. Expenses	45.50	43.40	8.00	7.86
	Total Grant in Aid- General	137.50	133.81	488.75	451.22
	Total Rev. (Grant in aid gen. + salaries)	137.50	133.81	1689.00	1481.42
	TOTAL (Capital + Revenue)	**277.00**	**273.06**	**1696.00**	**1488.32**
	Tribal Sub Plan Expenditure	0.00	0.00		
	NEH Expenditure	1.28	1.18		
	Non-Plan Schemes-Summer/Winter School	0.00	0.00		
	GRAND TOTAL	**278.28**	**274.23**	**1696.00**	**1488.32**
	Loans & Advances			7.14	5.29
REVENUE GENERATION					
	Financial Year	Target		Achievement	
	2016-17	50.74		50.91	

Plan Schemes

Sl. No.	Head of Expenditure	Other than NEH & TSP		NEH		Total	
		Approved RE	Expenditure	Approved RE	Expenditure	Approved RE	Expenditure
NWP on HPVA of NRG							
1	Grant-in-aid Capital	6.00	5.85	0.00	0.00	6.00	5.85
2	Grant-in-aid Salaries	0.00	0.00	0.00	0.00	0.00	0.00
3	Grant-in-aid-General	103.00	102.87	0.00	0.00	103.00	102.87
	Total	**109.00**	**108.72**	**0.00**	**0.00**	**109.00**	**108.72**
NWP on CLIGR							
1	Grant-in-aid Capital	26.75	26.75	0.00	0.00	26.75	26.75
2	Grant-in-aid Salaries	0.00	0.00	0.00	0.00	0.00	0.00
3	Grant-in-aid-General	112.25	112.24	0.00	0.00	112.25	112.24
	Total	**139.00**	**138.99**	**0.00**	**0.00**	**139.00**	**138.99**

Personnel

Details of scientific, technical, administrative and supporting staff (including KVK) as on December 31, 2016

Scientific	Sanctioned strength	In position
RMP	01	01
Principal Scientist	06	03
Sr. Scientist	15	07
Scientist	26	19
Total	**48**	**30**

Technical

Category-I	43	33
Category-II	23	09
Category-III	6	–
Total	**72**	**42**

Administrative

Sr. AO	01	01
F & AO	01	–
AAO	02	02
Private Secretary	01	01
Security Officer	01	01
JAO	01	01
PA	02	–
Assistant	11	11
Sr. Clerk	5	04
Jr. Clerk	6	01
Steno Gr. III	2	01
Total	**33**	**23**

Skilled Support Staff

SSS	84	50

Cadre	Sanctioned post	In position
Scientific	48*	30*
Technical	72	42
Administrative	33	23
Supporting	84	50
Total	**237**	**145**

**Including RMP*

Personnel

Dr. KK Sharma	Director

Lac Production Division

Dr. AK Singh, Pr. Sc. & I/c Head	Plant Pathology
Dr. S Ghosal, Pr. Sc.	Agronomy
Dr. Md Monobrullah, Pr. Sc.	Agril Entomology
Dr. J Ghosh, Sr. Sc.	Genet Plant Breeding
Dr. VD Lohot, Sc.	Plant Physiology
Dr. Anees K, Sc.	Plant Biochemistry
Dr. (Mrs.)Thamilarasi K, Sc.	Agril Biotechnology
Dr. A Mohanasundaram, Sc.	Agril Entomology
Sri SC Meena, Sc.	Agril Entomology (on study leave)
Dr. SS Bhat, Sc.	Agro Forestry
Sri Ashish Kr Raut, Sc.	Agril Entomology
Sri PA Ansari, STO	F/F Tech group
Sri SK Tripathi, STA	F/F Tech group
Sri Bhupal Kumar, Sr. Tech.	F/F Tech group
Sri SK Yadav,	Private Secretary

Processing and Product Development Division

Dr. N Prasad, Pr. Sc. & Head	AS & PE
Dr. PC Sarkar, Pr. Sc.	Agril Chem
Dr. S Srivastava, Pr. Sc.	Agril Chem
Dr. MZ Siddiqui, Pr. Sc.	Agril Chem
Dr. MF Ansari, Sr. Sc.	Agril Chem
Er. SK Pandey, Sc.	Mech Engg
Dr. SC Sharma, Sc.	FM & Power
Dr. AR Chowdhury, Sc.	Agril Chem
Sri N Thombare, Sc.	Agril Chem
Sri CJ Mate, Sc.	Agril Chem
Sri Md Ali, Sc.	Agril Chem
Dr. S Swami, Sc.	Agril Chem
Sri Ajay Kumar, STA	Lab Tech
Sri RK Rai, STA	Lab Tech
Sri Anup Kumar, STA	Lab Tech
Sri Binod Kumar, STA	Lab Tech

Transfer of Technology Division

Dr. AK Jaiswal, Pr. Sc. & I/c Head	Agril Entomology
Dr. Alok Kumar, Sr. Sc.	Agril Extension
Dr. AK Singh, Sr. Sc.	Agronomy
Dr. SKS Yadav, Sc.	Agril Chem
Dr. RK Yogi, Sc.	Agril Economics
Sri P Pattamajhi, STO	F/F Tech
Sri DK Singh, STO	F/F Tech
Sri AK Sinha, STO	F/F Tech
Sri SB Azad,TO	F/F Tech
Sri Madan Mohan, STA	F/F Tech

PME & IRIS Cell

Dr. MZ Siddiqui, Pr. Sc.	I/c
Sri D Ganguli, ACTO	Lab Tech
Sri Sunil Kumar, STO	Lab Tech

Quality Evaluation Lab (under PPD Division)

Dr. S Srivastava, Pr. Sc.	I/c
Sri BK Singh, STA	Lab Tech

Institute Research Farm (under LP Division)

Dr. A Mohanasundaram, Sc.	I/c
Sri Satish Kumar, TO	F/F Tech
Sri SK Mukherjee, STA	F/F Tech
Sri J Oraon, Sr. Tech.	W & Engg

LIbrary

Sri Binod Kumar, STO	Lib. Inf. & Documentation

Estate Section

Sri AK Yadav, SO	I/c Estate
Sri HL Bhakta, TO	W & Engg
Sri Binay Kumar, STA	W & Engg
Sri Arjun Sharma, STA	W & Engg
Sri RK Ravi, STA	W & Engg
Sri K Tirkey, STA	W & Engg
Sri BS Choudhary, STA	W & Engg
Sri PVD Tirkey, TA	W & Engg
Sri RK Singh, Sr. Tech.	W & Engg
Sri AK Sharma, Sr. Tech.	W & Engg
Sri Mahavir Mahto, Sr. Tech.	W & Engg
Sri Sukra Ekka, Sr. Tech.	W & Engg

Rajbhasha Prakosth

Dr. Anjesh Kumar, STO	P & E

Dispensary

Dr. PC Sarkar, Pr. Sc.	Chairman, DMC
Dr. Ashok Kumar	PMO
Dr. Kailash Prasad	PMO
Sri CK Singh, STA	Medical & Paramedical

Administration

Sri Sujit Kr Singh	Sr. AO

Admin I Section

Sri Anant Pandey	Assistant
Sri SC Lal	Assistant
Sri RN Mahto	Assistant
Sri Bihari Sahu	Assistant
Sri Bandhu Mahto	Jr. Clerk

Admin II Section

Sri Amrendra Kishore, AAO	DDO
Sri Arun Tripathi	Assistant
Sri RK Toppo	Assistant
Sri Samal Kumar	Sr. Clerk
Sri KP Kashi	Sr. Clerk

Admin III Section

Sri Prahlad Singh, AAO	I/c
Sri Ravi Shankar	Assistant
Sri KK Deonath	Sr. Clerk
Sri KM Kumar	Sr. Clerk

Audit & Accounts Section

Dr. MF Ansari, Sr. Sc.	I/c F & AO
Sri Ashwini Kumar	JAO
Sri T Minz	Assistant
Sri K Oraon	Assistant
Sri Arjun Gope	Assistant

Director Office

Sri Hari Vilas	Steno to Director

Vehicle Pool

Sri A Kumar, TO	W & Engg
Sri J Tewari, STA	W & Engg
Sri M Singh, STA	W & Engg
Sri RK Yadav, STA	W & Engg
Sri B Lakra, Sr. Tech.	W & Engg

A. Promotion

- Sri PA Ansari, TO promoted to the post of STO on 01.01.2016.
- Sri Satish Kumar, STA promoted to the post of TO on 05.6.2016.
- Sri Madan Mohan,TA promoted to the post of STA on 04.6.2016.
- Sri SK Mukherjee, TA promoted to the post of STA on 04.6.2016.
- Sri Sanjay Tripathi, TA promoted to the post of STA on 05.6.2016.
- Sri Ajay Kumar, TA promoted to the post of STA on 05.6.2016.
- Sri Binod Kumar, TA promoted to the post of STA on 04.6.2016.
- Sri Anup Kumar, TA promoted to the post of STA on 06.6.2016.
- Sri BK Singh, TA promoted to the post of STA on 05.6.2016.
- Sri RK Rai, TA promoted to the post of STA on 04.6.2016.
- Sri Arvind Kumar, STA promoted to the post of TO on 29.6.2016.
- Sri Jaswant Tiwari, TA promoted to the post of STA on 10.5.2015.
- Sri Arjun Sharma, TA promoted to the post of STA on 29.6.2016.
- Sri RK Ravi, TA promoted to the post of STA on 29.6.2016.
- Sri Kunwar Tirkey, TA promoted to the post of STA on 14.6.2016.
- Sri Mahavir Mahto, Technician promoted to the post of Sr. Technician 23.6.2015.
- Sri Bandi Lakra, Technician promoted to the post of Sr. Technician 23.6.2015.
- Sri Sukra Ekka, Technician promoted to the post of Sr. Technician 23.6.2015.
- Sri Jhirga Oraon, Technician promoted to the post of Sr. Technician 23.6.2015.

B. Transfer

- Sri GC Joshi, F & AO transferred from ICAR-IINRG, Ranchi to ICAR-CARI, Izatnagar (UP) on 31.5.2016.
- Dr. Alok Kumar, Sr. Sc. transferred from ICAR-IINRG, Ranchi to ICAR-NAARM, Hyderabad on 30.9.2016.
- Dr. Md Monobrullah, Pr. Sc. transferred from ICAR- IINRG, Ranchi to ICAR-Research Complex NEH Region, Patna (Bihar) on 21.11.2016.

C. Clearance of Probation Period & Confirmation

- Dr. AK Singh, Sr. Sc. (Agronomy) has completed his probation period on 17.10.2014 & confirmed on 18.10.2014.
- Sri CJ Mate, Sc. (Agril Chem) has completed his probation period on 31.12.2014 & confirmed on 01.01.2015.

D. Retirement

- Dr. R Ramani, Ex-Director IINRG, OSD IIAB and IARI, Jharkhand on 31.01.2016
- Sri Binod Kumar, TO on 30.4.2016
- Sri SK Tirkey, TA on 30. 4.2016
- Sri RP Srivastava, TO on 31.5.2016
- Sri KK Prasad, CTO on 31.7.2016
- Sri VK Singh, CTO on 31.7.2016
- Dr. AK Singh, Pr. Sc. on 31.12.2016

E. Death

- Sri Surajnath Toppo, SSS on 18.4.2016
- Sri Egnatius Lakra, SSS on 03.12.2016

Appendix

Appendix-I Skill development programmes on Scientific lac cultivation, processing and utilization

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of Participants
Farmers' training programme on Scientific lac cultivation, processing and utilization							
January	1	Forest Department, Dharamjay-garh, Raigarh (Chhattisgarh)	Chhattisgarh	11.01.16 to 15.01.16	13	-	13
		Forest Department, Korba (Chhattisgarh)	Chhattisgarh	11.01.16 to 15.01.16	10	-	10
		Private, Dhanbad	Jharkhand	11.01.16 to 15.01.16	01	-	01
	2	JASCOLAMPF, Ranchi (Simdega and Khunti district's farmers)	Jharkhand	18.01.16 to 21.01.16	52	-	52
February	3	JASCOLAMPF, Ranchi (Simdega and Khunti district's farmers)	Jharkhand	01.02.16 to 04.02.16	74	01	75
	4	JTDS, Ranchi (Jharkhand)	Jharkhand	08.02.16 to 11.02.16	32	-	32
	5	JTDS, Ranchi (Jharkhand)	Jharkhand	15.02.16 to 19.02.16	25	-	25
	6	JTDS, Ranchi (Jharkhand)	Jharkhand	22.02.16 to 26.02.16	25	-	25
March	7	JASCOLAMPF, Ranchi, Khunti district's farmers	Jharkhand	07.3.16 to 10.3.16	47	-	47
April	8	Udoyogini, Jharkhand	Jharkhand	04.4.16 to 08.4.16	35	05	40
	9	Udoyogini, Jharkhand	Jharkhand	19.4.16 to 23.4.16	19	07	26
May	10	Forest Department, Chaibasa, Jharkhand	Jharkhand	04.5.16 to 07.5.16	27	-	27
	11	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	09.5.16 to 13.5.16	36	-	36
		Forest Department, Simdega, Jharkhand	Jharkhand	09.5.16 to 13.5.16	08	-	08
	12	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	23.5.16 to 26.5.16	15	-	15
June	13	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	06.6.16 to 10.6.16	15	10	25
	14	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	13.6.16 to 17.6.16	15	-	15
July	15	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	28.6.16 to 01.7.16	23	-	23

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of Participants
July	16	Watershed Organization Trust (WOTR), Murhu, Khunti, Jharkhand	Jharkhand	11.7.16 to 05.7.16	02	30	32
		Private, Lapung, Ranchi	Jharkhand	11.7.16 to 05.7.16	01	-	01
August	17	DISHA, Chaibasha, Jharkhand	Jharkhand	16.8.16 to 20.8.16	24	-	24
September	18	ATMA, Madhya Pradesh	Madhya Pradesh	26.9.16 to 28.9.16	14	-	14
Sub-total					**513**	**53**	**566**
Master Trainers' training programme on Scientific lac production, processing and utilization							
January	1	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	04.01.16 to 08.01.16	03	04	07
		Forest Department, Bokaro, Jharkhand	Jharkhand	04.01.16 to 08.01.16	09	01	10
		Forest Department, Hazaribag, Jharkhand	Jharkhand	04.01.16 to 08.01.16	23	-	23
	2	Forest Department, Deoghar, Jharkhand	Jharkhand	18.01.16 to 23.01.16	44	-	44
	3	Jhalda Lac Growers Association, Purulia (West Bengal)	West Bengal	25.01.16 to 29.01.16	40	-	40
February	4	Village Re-Construction Organization (VRO)- India, Guntur (Andhra Pradesh)	Andhra Pradesh	01.02.16 to 05.02.16	15	-	15
		KVK Sirsi, Dharwad (Karnataka)	Karnataka	01.02.16 to 05.02.16	11	-	11
March	5	Forest Department (Jharkhand)	Jharkhand	29.02.16 to 05.3.16	22	-	22
April	6	UNCS, Nagpur (Maharashtra)	Maharashtra	28.3.16 to 01.4.16	14	-	14
		Forest Department, Godda (Jharkhand)	Jharkhand	28.3.16 to 02.4.16	08	-	08
		Private, Ranchi	Jharkhand	28.3.16 to 02.4.16	01	-	01
	7	Forest Department, Balrampur (Chhattisgarh)	Chhattisgarh	25.4.16 to 30.4.16	20	-	20
May	8	Hariyare Ashra, Kamrup (Assam)	Assam	16.5.16 to 21.5.16	24	-	24
		CINI, Jharkhand through SUPPORT, Hazaribag (Jharkhand)	Jharkhand	16.5.16 to 21.5.16	06	-	06
		CINI, Jharkhand through NBJK, Khunti (Jharkhand)	Jharkhand	16.5.16 to 21.5.16	05	01	06
		CINI, Deoghar (Jharkhand)	Jharkhand	16.5.16 to 21.5.16	08	-	08
	9	Forest Department (Chhattisgarh)	Chhattisgarh	23.5.16 to 28.5.16	37	-	37

Month	Course No.	Sponsoring Organization	State	Period	M	F	No. of Participants
November	10	Jharkhand State Livelihood Promotion Society (JSLPS), Jharkhand	Jharkhand	21.11.16 to 26.11.16	32	04	36
Sub-total					**322**	**10**	**332**
Educational programme on production, processing and uses of natural resins and gums							
February	1	Guru Ghasidas University, Bilaspur, Chhattisgarh (M.Sc. Forestry students) on Industrial Training on Natural Resins and Gums	Chhattisgarh	15.02.16 to 29.02.16	03	06	09
March	2	Guru Ghasidas University, Bilaspur, Chhattisgarh (B.Sc. Forestry students)	Chhattisgarh	07.3.16 to 16.3.16	21	12	33
June	3	8th Summer Workshop on Natural Resins and Gums (10 days) N.G. Ranga Agricultural University (Andhra Pradesh)	Andhra Pradesh	30.5.16 to 08.6.16	-	01	01
		Institute of Agriculture, BHU, Varanasi (Uttar Pradesh)	Uttar Pradesh	30.5.16 to 08.6.16	24	15	39
	4	9th Summer Workshop on Natural Resins and Gums (10 days) Institute of Agriculture, BHU, Varanasi (Uttar Pradesh)	Uttar Pradesh	13.6.16 to 22.6.16	05	11	16
		Sam Higginbottom Institute of Agriculture, Technology and Sciences (SHIATS), Allahabad (Uttar Pradesh)	Uttar Pradesh	13.6.16 to 22.6.16	16	19	35
October	5	5th Winter Workshop on Natural Resins and Gums (10 days) M.Sc. (Rural Technology & Development) students from University of Allahabad (Uttar Pradesh)	Uttar Pradesh	17.10.16 to 26.10.16	11	05	16
		B.Sc. (Bio Technology) students from St. Xavier's College, Ranchi	Jharkhand	18.10.16 to 27.10.16	03	19	22
Sub-total					**83**	**88**	**171**
Short term training program (Refresher Course) on Scientific lac cultivation, processing and uses							
November	1	Jharkhand State Livelihood Promotion Society (JSPLS), Jharkhand	Jharkhand	16.11.16 to 18.11.16	27	11	38
December	2	Jharkhand State Livelihood Promotion Society (JSPLS), Jharkhand	Jharkhand	05.12.16 to 07.12.16	15	04	19
Sub-total					**42**	**15**	**57**
Total					**960**	**166**	**1126**

Appendix-II On-farm training programme

Camp No.	District – State	Sponsoring/ Nominating Agency	Venue (Village, Block)	Dated	M	F	No. of Participants
On-farm training programme on scientific lac cultivation							
1.	Khunti, Jharkhand	Forest Department, Khunti	DFO Office, Khunti	05.01.16	60	05	65
2.	Latehar, Jharkhand	Forest Department, Latehar	Range Office, Chandwa	24.02.16	80	-	80
3.	Latehar, Jharkhand	Forest Department, Latehar	G.H.Campus, Latehar	25.02.16	60	-	60
4.	Bokaro, Jharkhand	Forest Department, Bokaro	Van Sabhagar, Peterwar	05.3.16	66	12	78
5.	Simdega, Jharkhand	Forest Department, Simdega	Beat Office, Tethaitangar	11.3.16	64	02	66
6.	Simdega, Jharkhand	Forest Department, Simdega	Range Office, Kurdeg	11.3.16	70	10	80
7.	Simdega, Jharkhand	Forest Department, Simdega	Forest Range Office, Kolebira	11.3.16	46	05	51
8.	Dhanbad, Jharkhand	Forest Department, Dhanbad	Forest Office, Gadi Tundi	16.3.16	136	12	148
9.	Dumka, Jharkhand	Forest Department, Dumka	R.F.O.Office, Nonehat Campus	17.3.16	34	-	34
10.	Dumka, Jharkhand	Forest department, Dumka	R.F.O.Office, Kathikund	17.3.16	60	-	60
11.	Godda, Jharkhand	Forest Department, Godda	R.F.O.Office, Boarijore Mahagama	18.3.16	18	-	18
12.	Godda, Jharkhand	Forest Department, Godda	RFO Office, Sunder Pahari	18.3.16	45	0	45
13.	Simdega, Jharkhand	Chotanagpur Vikas Nidhi, Lachragarh	Panchyat Bhavan, Jaldega	07.6.16	70	14	84
14.	Simdega, Jharkhand	Chotanagpur Vikas Nidhi, Lachragarh	S S High School Hall, Jaldega	08.7.16	179	32	211
Sub-total					**988**	**92**	**1080**
On-farm, Motivational/supplementary training programme on lac cultivation							
1.	Khunti, Jharkhand	Forest Department, Khunti	Rania Block Office	08.01.16	60	-	60
2.	Chaibasa, Jharkhand	TRIFED, Ranchi & AGRGATI	AGRGATI Office, Chaibasa	03.02.16	29	-	29
3.	Chaibasa, Jharkhand	TRIFED, Ranchi & AGRGATI	Kulbai Primary School, Chaibasa	04.02.16	40	-	40
4.	Ranchi, Jharkhand	TRIFED, Ranchi & AGRGATI	Anganbadi Kendra, Hesalbera	05.02.16	47	02	49
5.	W. Singhbhum, Jharkhand	TRIFED, Ranchi & AGRGATI	Choukadbera Samudayek Bhavan	11.02.16	80	40	120

Camp No.	District – State	Sponsoring/ Nominating Agency	Venue (Village, Block)	Dated	M	F	No. of Participants
6.	W. Singhbhum, Jharkhand	TRIFED, Ranchi & AGRGATI	Gobindpur Basik School	12.02.16	40	10	50
7.	Ramgarh, Jharkhand	TRIFED, Ranchi & AGRGATI	Uppar Primary School, Barlanga	13.02.16	40	20	60
8.	Saraikela-Kharsawan, Jharkhand	TRIFED, Ranchi & Kalamandir (NGO) Jamshedpur	Kala Kendra Bhawan, Ichagarh	15.02.16	100	50	150
9.	Ramgarh, Jharkhand	TRIFED, Ranchi & Kalamandir (NGO) Jamshedpur	Govt. Middle School, Baruhatu	16.02.16	25	15	40
10.	Saraikela-Kharsawan, Jharkhand	TRIFED, Ranchi & Kalamandir (NGO) Jamshedpur	Kala Kendra Bhawan, Ichagarh	17.02.16	95	55	150
11.	Khunti, Jharkhand	CINI, Murhu, Khunti	Dombari, Murhu	09.3.16	05	20	25
12.	Khunti, Jharkhand	CINI, Murhu, Khunti	Gutuhatu, Murhu	09.3.16	01	25	26
13.	Shillong, Meghalaya	MIE, Shillong	IB PWD Sohlab Shella, East Khasi Hill	24.5.16	18	10	28
14.	Shillong, Meghalaya	MIE, Shillong	Multipurpose Co-operative Society Office, Mawlong-Nongttuh, Ri-Bhoi, Umilong	26.5.16	17	12	29
Sub-total					**597**	**259**	**856**
Total					**1585**	**351**	**1936**

Appendix- III In-campus one-day orientation programme on natural resins and gums

Camp No.	District –State	Nominating Agency	Dated	M	F	No. of Participants
1.	Hazaribagh, Jharkhand	Forest Department	04.01.16	16	-	16
2.	Ramgarh, Jharkhand	Forest Department	04.01.16	01	09	10
3.	Ranchi, Jharkhand	RK Mission, Ranchi	04.01.16	43	-	43
4.	Koderma, Jharkhand	ATMA, Kodarma	07.01.16	25	-	25
5.	Raigarh, Chhattisgarh	Forest Department, Dharamjaigarh	11.01.16	23	-	23
6.	Ranchi, Jharkhand	JAMTTC, Hehal, Ranchi	12.01.16	55	-	55
7.	Ramgarh, Jharkhand	Ramgarh College, Ramgarh	15.02.16	05	13	18
8.	Ranchi, Jharkhand	RK Mission, Ranchi	16.02.16	35	-	35
9.	Khunti, Jharkhand	TRDS, Torpa, Khunti	17.02.16	30	-	30
10.	Ranchi, Jharkhand	RK Mission Vivekananda University, Ranchi	18.02.16	14	10	24
11.	Ranchi, Jharkhand	BAU, Kanke, Ranchi	18.02.16	92	06	98
12.	Ranchi, Jharkhand	RK Mission, Ranchi	29.02.16	36	02	38

Camp No.	District –State	Nominating Agency	Dated	M	F	No. of Participants
13.	Ranchi, Jharkhand	RK Mission, Ranchi	09.3.16	40	03	43
14.	Ranchi, Jharkhand	Y S College, Ranchi	09.3.16	20	13	33
15.	Ranchi, Jharkhand	BAU, Kanke, Ranchi	11.3.16	15	02	17
16.	Ranchi, Jharkhand	Nawa Maskal School, Bayangdih, Namkum	17.3.16	33	-	33
17.	Ranchi, Jharkhand	BAU, Kanke, Ranchi	17.3.16	25	-	25
18.	Ranchi, Jharkhand	BAU, Kanke, Ranchi	18.3.16	19	03	22
19.	Ranchi, Jharkhand	RK Mission, Ranchi	19.3.16	33	-	33
20.	W. Singhbhum, Jharkhand	JSLPS, W Singhbhum, Jharkhand	21.3.16	37	06	43
21.	Ranchi, Jharkhand	RK Mission, Ranchi	13.5.16	30	-	30
22.	Ranchi, Jharkhand	Ranchi college, Ranchi	18.5.16	02	08	10
23.	Ranchi, Jharkhand	Central University, Ranchi	18.5.16	22	18	40
24.	Gumla, Jharkhand	Adivashi Mahila Seva Samaj Kendra, Gumla	08.6.16	30	21	51
25.	Gumla, Jharkhand	Adivashi Mahila Seva Samaj Kendra, Gumla	14.6.16	30	30	60
26.	Ranchi, Jharkhand	BITT, Getalatu, Ranchi, 1st Year Mechanical Engineering students	08.7.16	88	-	88
27.	Chaibasha, Jharkhand	Kolhan Mahila Sangathan, Chaibasha	29.8.16	50	-	50
28.	Ranchi, Jharkhand	RK Mission, Ranchi	30.8.16	45	05	50
29.	Raigarh, Chhattisgarh	Progressive farmers	14.9.16	18	22	40
30.	Deoghar, Jharkhand	ASA, Deoghar	16.9.16	06	07	13
31.	Ranchi, Jharkhand	SPP School, Ranchi	19.9.16	22	23	45
32.	Ranchi, Jharkhand	Bishop Westcott Girls School, Namkum	19.9.16	-	232	232
33.	Ranchi, Jharkhand	Bishop Westcott Girls School, Doranda	19.9.16	-	316	316
34.	Ranchi, Jharkhand	CTR & TI, Nagri, Ranchi	20.9.16	18	14	32
35.	Ranchi, Jharkhand	Sachidanand Gyan Bharti Model School, Doranda, Ranchi	21.9.16			77
36.	Ranchi, Jharkhand	Bishop Westcott Girls School, Namkum	21.9.16			118
37.	Ranchi, Jharkhand	Project High School, Namkum	21.9.16			70
38.	Ranchi, Jharkhand	KGBV, Namkum	21.9.16	02	43	45
39.	Ranchi, Jharkhand	Uccah Buniyadi Vidyalaya, Khijri, Namkum	21.9.16			104
40.	Ranchi, Jharkhand	Udyogini, Ranchi	22.9.16	05	50	55
41.	Seoni, Madhya Pradesh	ATMA, Seoni, Madhya Pradesh	26.9.16	15	-	15
42.	Hazaribag, Jharkhand	Manav Vikas, Hazaribag	30.9.16	06	42	48
43.	Khunti, Jharkhand	PRADAN, Khunti	04.10.16	03	29	32
44.	W. Singhbhum, Jharkhand	ITDS, Goilkera	04.10.16	35	-	35
45.	W. Singhbhum, Jharkhand	ITDS, Goilkera	07.10.16	20	10	30

Camp No.	District –State	Nominating Agency	Dated	M	F	No. of Participants
46.	Ranchi, Jharkhand	Mahila Jagriti Samiti, Tamar, Ranchi	14.10.16	24	-	24
47.	Ranchi, Jharkhand	CTR & TI, Nagri, Ranchi	26.10.16	03	10	13
48.	Hawrah, W.Bengal	Farmers from Howrah, through RK Mission, Ranchi	27.10.16	13	-	13
49.	Nadia, W.Bengal	ATMA, West Bengal	08.11.16	20	-	20
50.	Ranchi, Jharkhand	XISS, Ranchi	08.11.16	37	37	74
51.	Ranchi, Jharkhand	Nehru Yuva Kendra, Ranchi	10.11.16	23	17	40
52.	Ranchi, Jharkhand	XISS, Ranchi	11.11.16	16	09	25
53.	Ranchi, Jharkhand	RK Mission, Ranchi	26.11.16	13	-	13
54.	Ranchi, Jharkhand	NSDAV, Kanke, Ranchi	26.11.16	56	-	56
55.	Ranchi, Jharkhand	Naya Savera Vikas Kendra, Ranchi	01.12.16	34	12	46
56.	Hazaribag, Jharkhand	St. Columbus College, Hazaribag	07.12.16	16	24	40
57.	Gumla, Jharkhand	Adivasi Mahila Samaj Seva Kendra, Gumla	08.12.16	18	-	18
58.	Khunti, Jharkhand	PRADAN, Torpa	08.12.16	10	50	60
59.	Ranchi, Jharkhand	International Public School, Ranchi	12.12.16	47	50	97
60.	Ranchi, Jharkhand	STTI, Mahilong, Ranchi	15.12.16	40	15	55
61.	Ranchi, Jharkhand	Society for Promotion of Waterland Development (SPWD), Ranchi	17.12.16	06	16	22
62.	Ranchi, Jharkhand	Society for Promotion of Waterland Development (SPWD), Ranchi	21.12.16	08	30	38
63.	Ranchi, Jharkhand	NCC Students, Army Cantt, Namkum	21.12.16	250	-	250
64.	Khunti, Jharkhand	PRADAN, Khunti	21.12.16	15	14	29
65.	Ranchi, Jharkhand	Forest Department, Mahilong, Ranchi	22.12.16	56	04	60
66.	Sundargarh, Odisha	Assistant Director of Horticulture, Pamposh	23.12.16	32	02	34
67.	Purulia, West Bengal	Assistant Director of Agriculture, Purulia-1	26.12.16	12	-	12
68.	Purulia, West Bengal	ATMA, Purulia, West Bengal	29.12.16	56	01	57
69.	Khunti, Jharkhand	PRADAN, Khunti	30.12.16	05	20	25
Total				**1854**	**1248**	**3471**

Appendix- IV Details of the activities of NIC and MOTAS under one to one programme (OTOP)

State		District	Category	Number
1.	Andhra Pradesh	Tirupati	Researcher	1
2.	Assam	Chirang	Farmer	1
		Dhemaji	Extension worker	4
			Farmer	1
		North lakhimpur	Researcher	1
3.	Bihar	Patna	Researcher	1

State		District	Category	Number
4.	Chhattisgarh	Bilaspur	Extension worker	12
			Farmer	6
		Kanker	Entrepreneur	1
		Raipur	Extension worker	1
		Rajnandgaon	Researcher	1
		Surajpur	Extension worker	1
5.	Delhi	Delhi	Researcher	4
			Retailers	17
6.	Gujarat	Anand	Researcher	2
			Farmer	1
		Bharuch	Farmer	4
		Surat	Extension worker	4
			Farmer	4
7.	Jharkhand	Giridih	Extension worker	1
		Gumla	Extension worker	1
		Hazaribagh	Extension worker	1
			Progressive Farmer	9
		Khunti	Farmer	1
		Ranchi	Farmer	13
			Trader	2
			Processor	1
			Social worker	1
			Extension worker	6
			Entrepreneur	2
8.	Maharashtra	Nagpur	Social worker	1
		Sholapur	Social worker	2
9.	Nepal	Kathmandu	Entrepreneur	3
10.	Odisha	Sundergarh	Social worker	1
		Rourkela	Entrepreneur	1
11.	Rajasthan	Ajmer	Forest official	3
			Trader	2
			Handicrafts man	4
			Processor	1
			Exporter	1
			Manufacturer	2
			Retailer	3

State		District	Category	Number
		Jaipur	Researcher	5
			Exporter	5
			Traders	2
			Handicrafts man	3
			Processor	2
			Farmer	15
12.	Uttarakhand	Dehradun	Researcher	5
			Retailer	2
13.	West Bengal	Nadia	Manufacturer	1
Total				**169**

Appendix- V Lac crop surveillance conducted

Camp No.	Village (block)	District –State	Date	Crop	Observation
1.	Kapla bori chauda and bamundi Tari (Naruwa)	Nalbari, Assam	03.01.16	*Rangeeni* lac on *Z. mauritiana*	Lac cultivation was done in 34 villages (1915 *ber* trees of 1000 beneficiaries) in Dimapur (Nagaland) and 395 beneficiaries in Assam with *kusmi* lac culture on *ber*. Very poor settlement of lac insects was seen on most of the *ber* trees. Mortality of settled insect was noticed on many trees; however on few trees, lac insect were surviving and developing.
2.	Cheniyan	Sonitpur, Assam	04.01.16	*Rangeeni* lac on *Z. mauritiana*	
3.	Chekiya, Dihupur, Kiyeto, Dansiripur, Doyapur, Lhothavi, Ghowoto, Verozoma and Zutovi	Dimapur, Assam	05.01.16	*Rangeeni* lac on *Z. mauritiana*	
4.	Kucheirmohar (Khatra Block)	Bankura, West Bengal	24.02.16	*Rangeeni* lac on *Z. Mauritiana* and *B. monosperma*	*Rangeeni* lac was surviving on *ber* and *palas* as *baisakhi* (2015-16). Crop was in good condition.
5.	Karamdanga (Ranidih Block)	Bankura, West Bengal	24.02.16	*Rangeeni* lac on *Z. Mauritiana* and *B. monosperma*	Healthy crop.
6.	Damrughhuta and Majhidih (Kotshila Block)	Purulia, West Bengal	09.3.16	*Rangeeni* lac on *B. monosperma*	*Rangeeni* crop on *palas* tree in excellent condition in both villages. Male emergence was over. Pesticides were applied in time.
7.	Bhandaro and Rajapathar (Nonihat Block)	Dumka, Jharkhand	17.3.16	*Rangeeni* lac on *B. monosperma*	*Rangeeni* crop on *palas* was in good condition. Heavy settlement, male emergence seen. No insecticide and pesticide applied.
8.	Paharpur (Mahagama Block)	Godda, Jharkhand	18.3.16	*Rangeeni* lac on *Z. Mauritiana* and *B. monosperma*	*Rangeeni* crop on *palas* as well on *ber* was good, heavy settlement, male emergence started, no spray.
9.	Paharpur (Mahagama Block)	Godda, Jharkhand	17.3.16	*Rangeeni* lac on *B. monosperma*	*Rangeeni* lac crop on *palas* was in very good condition.

Camp No.	Village (block)	District –State	Date	Crop	Observation
10.	Jama, Dumka	Dumka, Jharkhand	17.3.16	*Rangeeni* lac on *B. monosperma*	*Rangeeni* lac crop on *palas* was in very good condition.
11.	Herbona (barabazar Block)	Purulia, West Bengal	02.4.16	*Rangeeni* lac on *Z. Mauritiana*	*Rangeeni* on *ber* was observed in good condition. Insecticide and pesticide were applied in time.
12.	Nuadih (Manbazar-II Bl16ock)	Purulia, West Bengal	02.4.16	*Rangeeni* lac on *Z. Mauritiana*	
13.	Latpada (Manbazar-II Block)	Purulia, West Bengal	02.4.16	*Rangeeni* lac on *Z. Mauritiana* and *B. monosperma*	*Rangeeni* on *palas* and *ber* was in good condition. Insecticide and pesticide were applied in time.
14.	Nongmawtein (Mawshynput Block)	West Khasi Hills, Meghalaya	25.5.16	*Rangeeni* crop on *Grivea*	*Rangeeni* crop on *Grivea* plants observed in this region. Larval emergence seen. Temperature is below 30^0 C and lac also collected from ficus trees.
15.	Patrapali and Thakur Kheta	Korba, Chhattisgarh	30.5.16	*Kusmi* crop on *S. oleosa*	Healthy crop.
	Rajgamar				Healthy crop sprayed with indoxacarb.
	Kerakachar				Healthy crop sprayed with regent.
	Darga				Partially damaged due to high temperature and crop sprayed with regent.
	Madanpur				Healthy crop sprayed with regent.
	Korkum				Healthy crop.
	Matmar				Healthy crop sprayed with indoxacarb.
	Murhunara				Excellent crop sprayed with indoxacarb.
	Marumohaa				Average crop.
16.	Bhalmudi, Poriya, Sangra and Sakarliya	Dharamjaigarh, Raigarh	01.6.16	*Kusmi* crop on *S. oleosa*	Below average to very good crop.
17.	Siyankel (Murhu Block)	Khunti, Jharkhand	01.9.16	*Kusmi* crop on *S. oleosa*	Poor settlement due to heavy rainfall after inoculation. Males were crawling.
18.	Manhatu (Torpa Block)	Khunti, Jharkhand	01.9.16	*Kusmi* crop on *S. oleosa*	Good settlement. Males were crawling and first spray was done on proper time.
19.	Uppar and lower Dahu (Namkum Block)	Ranchi, Jharkhand	21.9.16	*Kusmi* crop on *Z. Mauritiana*	Inoculation with broodlac treatment and without treatment was done with *kusmi* on *ber*. Treated crop was better than non treated crop.
20.	Ashavani and Kamedmaria	Dumka, Jharkhand	19.10.16	*Kusmi* crop on *Z. Mauritiana*	Inoculation with broodlac treatment was good and average.

Appendix- VI Participation in Exhibition/*Kisan Mela*

Sl. No.	Name of the programme with venue	Duration	No. of Participants			Expert Participation
			F	M	Total	
1.	Exhibition at Paschimanchal Unnayan Parshad, Jhargram, WB	05.01.2016-09.01.2016	250	800	1050	Sri SB Azad and Sri K Saran
2.	Exhibition and *Kisan Mela* at KVK Farm, Getalsud, Ranchi	28.01.2016-29.01.2016	200	500	700	Sri P Patmajhi, Sri SB Azad and Sri K Saran
3.	*Krishi Unnati Mela* 2016 at ICAR-IARI Campus, New Delhi	19.3.216-21.3.2016	60000	100000	160000	Sri P Patmajhi and Sri K Saran
4.	Pradhanmantri Fasal Beema Yojna at Nagar Bhawan, Torpa, Khunti	13.4.2016	175	25	200	Dr. AK Singh, Sri DK Singh and Sri K Saran
5.	Agriculture Fair on the Occasion of Gramoday se Bharat Uday Programme at Sports Complex, Jamshedpur	23.4.2016-24.4.2016	105	201	306	Dr. Alok Kumar, Dr. AK Singh and Sri DK Singh
6.	Prajatiya Khadi Utsav Exhibition at Noamundi, Sport Complex (Organised by Tata Steel Limited)	04.11.2016	673	457	1130	Sri DK Singh and Sri K Saran
7.	Kisan Mela-cum-Exhibition (*Lakh se Lakhpati Kisan*) at Kajri, Hazaribagh	08.12.2016	400	200	600	Dr. AK Jaiswal, Sri P Patmajhi and Sri K Saran
8.	Kisan Mela-cum-Exhibition (*Lakh se Lakhpati Kisan*) at Saparum, Khunti	13.12.2016	400	100	500	Sri P Patmajhi and Sri K Saran
Total			**62203**	**102283**	**164486**	

Appendix- VII *Kisan Gosthi*/Workshop/FIG/Interface meetings

Sl. No.	Venue	Collaboration	Date	No. of stakeholders			Experts
				F	M	Total	
1.	KVK Farm, Getal-sud, Ranchi	KVK, Ranchi (RK Mission)	29.01.2016	275	300	575	Dr. SP Singh and Sri DK Singh
2.	Khelgaon, Ranchi	Gunj Parivar (Pratibha Darshan Mahotsav), Silli	04.02.2016	25	300	325	Sri DK Singh
3.	Khelgaon, Ranchi	Gunj Parivar (Pratibha Darshan Mahotsav), Silli	06.02.2016	25	315	340	Sri DK Singh
4.	Forest Range Office, Bundu, Ranchi	Forest Department, Bundu, Ranchi	14.02.2016	5	100	105	Sri DK Singh

Sl. No.	Venue	Collaboration	Date	No. of stakeholders			Experts
				F	M	Total	
5.	Torpa Rural Development Society, Torpa, Khunti	KVK, Khunti	29.3.2016	100	90	190	Dr. AK Singh and Sri DK Singh
6.	Jaipal Singh Stadium, Bano, Ranchi	KVK, Bano	09.4.2016	256	350	606	Sri DK Singh
7.	Jonha, Ranchi	Direct by villagers	30.5.2016	100	75	175	Dr. Alok Kumar, Dr. SC Sharma and Sri DK Singh
8.	Beradih, Namkum, Ranchi	Under MGMG Programme	04.6.2016	6	14	20	Dr. AK Singh, Dr. SKS Yadav and Dr. MF Ansari
9.	Beradih, Namkum, Ranchi	Under MGMG Programme	08.7.2016	13	27	40	Dr. SKS Yadav and Sri P Patmajhi
10.	Surhu, Kamdara	JASCOLAMPF	14.9.2016	105	45	150	Sri DK Singh
11.	TRDS, Torpa, Khunti	TRDS, Torpa, Khunti	14.9.2016	60	70	130	Dr. AK Singh, Dr. SKS Yadav and Dr. MF Ansari
12.	Kundari Lac Farm, Palamu	Ridhi Sidhi Primari Lac Production Samiti, Kundri	28.11.2016	160	130	290	Dr. KK Sharma and Sri DK Singh
Total				**1130**	**1816**	**2946**	

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